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(71) Applicant (for all designated States except US): MILLENNIUM PHARMACEUTICALS, INC. [US/US]; 75 Sidney Street, Cambridge, MA 02139 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): MEYERS, Rachel, A. [US/US]; 115 Devonshire Road, Newton, MA 02468 (US).

(74) Agents: MYERS, Louis et al.; Fish & Richardson P.C., 225 Franklin Street, Boston, MA 02110-2804 (US).

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(54) Title: 47508, A NOVEL HUMAN HISTONE DEACETYLASE FAMILY MEMBER AND USES THEREOF

(57) Abstract: The invention provides isolated nucleic acids molecules, designated 47508 nucleic acid molecules, which encode novel human histone deacetylase members. The invention also provides antisense nucleic molecules, recombinant expression vectors containing 47508 nucleic acid molecules, host cells into which the expression vectors have been introduced, and nonhuman transgenic animals in which a 47508 gene has been introduced or disrupted. The invention still further provides isolated 47508 proteins, fusion proteins, antigenic peptides and anti-47508 antibodies. Diagnostic methods utilizing compositions of the invention are also provided.

47508, A NOVEL HUMAN HISTONE DEACETYLASE FAMILY MEMBER
AND USES THEREOF

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Related Applications

This application claims priority to U.S. provisional application number 60/220,008 filed on July 21, 2000, the contents of which are incorporated herein by reference.

Background of the Invention

Chromatin is a complex of DNA and proteins. The protein component of chromatin 10 includes five different proteins, known collectively as histones. The histones are designated H1, H2A, H2B, H3 and H4 and are highly conserved across genera. Two of each of the histones H2A, H2B, H3, and H4 form a core octomer complex around which DNA is wrapped, or spooled, leading to its condensation.

Histones undergo numerous alterations during the cell cycle (reviewed in 15 Mahlknecht and Hoelzer (2000), Molecular Medicine 6(8):623-44). For example, histone H4 is acted upon by a battery of enzymes that carry out various covalent modifications. In particular, four lysine residues in the N-terminal region of histone H4 undergo reversible acetylation. This enzymatic reaction is catalyzed by a histone acetylase, which adds acetyl groups donated by acetyl CoA. The acetyl groups are removed by a hydrolysis reaction 20 catalyzed by a histone deacetylase. Histones H2A, H2B, and H3 are likewise acetylated and deacetylated.

Acetylation and other covalent modifications alter the net charge of histones. For example, the unmodified histone H4 has a net charge of +5, while the fully modified protein 25 has a net charge of -2. This change in net charge alters the affinity of histones or particular histone domains for DNA and for other proteins. Histone acetylation, which shifts the net charge of histones in the negative direction, leads to the unraveling of chromatin, which is often accompanied by an increase in gene transcription in the unraveled region. Conversely, histone deacetylation shifts the net charge of histones in the positive direction, strengthening the interaction between histones and DNA, and leading to chromosomal condensation. 30 Chromosomal condensation is associated with the silencing of DNA transcription. Thus, the enzymes involved in the covalent modification of histones, histone acetylases and histone deacetylases, play a regulatory role in DNA replication and transcription. Through these

activities, histone acetylases and deacetylases are believed to influence major cellular processes, such as differentiation and proliferation, as well as abnormal processes like tumor growth (Mahlknecht and Hoelzer (2000), *supra*).

Summary of the Invention

5 The present invention is based, in part, on the discovery of a novel histone deacetylase family member, referred to herein as "47508". The nucleotide sequence of a cDNA encoding 47508 is recited in SEQ ID NO:1, and the amino acid sequence of a 47508 polypeptide is recited in SEQ ID NO:2 (see also Example 1, below). In addition, the nucleotide sequences of the coding region are depicted in SEQ ID NO:3.

10 Accordingly, in one aspect, the invention features a nucleic acid molecule that encodes a 47508 protein or polypeptide, e.g., a biologically active portion of the 47508 protein. In a preferred embodiment the isolated nucleic acid molecule encodes a polypeptide having the amino acid sequence of SEQ ID NO:2. In other embodiments, the invention provides isolated 47508 nucleic acid molecules having the nucleotide sequence 15 shown in SEQ ID NO:1, SEQ ID NO:3, or the sequence of the DNA insert of the plasmid deposited with ATCC Accession Number _____. In still other embodiments, the invention provides nucleic acid molecules that are substantially identical (e.g., naturally occurring allelic variants) to the nucleotide sequence shown in SEQ ID NO:1, SEQ ID NO:3, or the sequence of the DNA insert of the plasmid deposited with ATCC Accession Number _____.
20 In other embodiments, the invention provides a nucleic acid molecule which hybridizes under a stringency condition described herein to a nucleic acid molecule comprising the nucleotide sequence of SEQ ID NO:1, SEQ ID NO:3, or the sequence of the DNA insert of the plasmid deposited with ATCC Accession Number _____, wherein the nucleic acid encodes a full length 47508 protein or an active fragment thereof.
25 In a related aspect, the invention further provides nucleic acid constructs that include a 47508 nucleic acid molecule described herein. In certain embodiments, the nucleic acid molecules of the invention are operatively linked to native or heterologous regulatory sequences. Also included, are vectors and host cells containing the 47508 nucleic acid molecules of the invention e.g., vectors and host cells suitable for producing 47508 nucleic acid molecules and polypeptides.
30 In another related aspect, the invention provides nucleic acid fragments suitable as primers or hybridization probes for the detection of 47508-encoding nucleic acids.

In still another related aspect, isolated nucleic acid molecules that are antisense to a 47508 encoding nucleic acid molecule are provided.

In another aspect, the invention features, 47508 polypeptides, and biologically active or antigenic fragments thereof that are useful, e.g., as reagents or targets in assays applicable 5 to treatment and diagnosis of 47508-mediated or -related disorders. In another embodiment, the invention provides 47508 polypeptides having a 47508 activity. Preferred polypeptides are 47508 proteins including at least one histone deacetylase domain, and, preferably, having a 47508 activity, e.g., a 47508 activity as described herein.

In other embodiments, the invention provides 47508 polypeptides, e.g., a 47508 10 polypeptide having the amino acid sequence shown in SEQ ID NO:2 or the amino acid sequence encoded by the cDNA insert of the plasmid deposited with ATCC Accession Number ____; an amino acid sequence that is substantially identical to the amino acid sequence shown in SEQ ID NO:2 or the amino acid sequence encoded by the cDNA insert of the plasmid deposited with ATCC Accession Number ____; or an amino acid sequence 15 encoded by a nucleic acid molecule having a nucleotide sequence which hybridizes under a stringency condition described herein to a nucleic acid molecule comprising the nucleotide sequence of SEQ ID NO:1, SEQ ID NO:3, or the sequence of the DNA insert of the plasmid deposited with ATCC Accession Number ____; wherein the nucleic acid encodes a full length 47508 protein or an active fragment thereof.

20 In a related aspect, the invention provides 47508 polypeptides or fragments operatively linked to non-47508 polypeptides to form fusion proteins.

In another aspect, the invention features antibodies and antigen-binding fragments thereof, that react with, or more preferably specifically bind 47508 polypeptides or fragments thereof, e.g., a histone deacetylase domain of 47508.

25 In another aspect, the invention provides methods of screening for compounds that modulate the expression or activity of the 47508 polypeptides or nucleic acids.

30 In still another aspect, the invention provides a process for modulating 47508 polypeptide or nucleic acid expression or activity, e.g. using the screened compounds. In certain embodiments, the methods involve treatment of conditions related to aberrant activity or expression of the 47508 polypeptides or nucleic acids, such as conditions involving aberrant or deficient cellular proliferation or differentiation.

The invention also provides assays for determining the activity of or the presence or absence of 47508 polypeptides or nucleic acid molecules in a biological sample, including for disease diagnosis.

In yet another aspect, the invention provides methods for inhibiting the proliferation or inducing the killing, of a 47508-expressing cell, e.g., a hyper-proliferative 47508-expressing cell. The method includes contacting the cell with an agent, e.g., a compound, (e.g., a compound identified using the methods described herein) that modulates the activity, or expression, of the 47508 polypeptide or nucleic acid. In a preferred embodiment, the contacting step is effective *in vitro* or *ex vivo*. In other embodiments, the contacting step is effected *in vivo*, e.g., in a subject (e.g., a mammal, e.g., a human), as part of a therapeutic or prophylactic protocol. Preferably, the cell is a hyperproliferative cell, e.g., a cell found in a solid tumor, a soft tissue tumor, or a metastatic lesion. In another preferred embodiment, the cell or tumor is found in, e.g., a breast, ovary, lung, colon, or liver, tissue.

In a preferred embodiment, the compound is an inhibitor of a 47508 polypeptide. 15 Preferably, the inhibitor is chosen from a peptide, a phosphopeptide, a small organic molecule, a small inorganic molecule and an antibody (e.g., an antibody conjugated to a therapeutic moiety selected from a cytotoxin, a cytotoxic agent and a radioactive metal ion). In another preferred embodiment, the compound is an inhibitor of a 47508 nucleic acid, e.g., an antisense, a ribozyme, or a triple helix molecule.

20 In a preferred embodiment, the compound is administered in combination with a cytotoxic agent. Examples of cytotoxic agents include anti-microtubule agent, a topoisomerase I inhibitor, a topoisomerase II inhibitor, an anti-metabolite, a mitotic inhibitor, an alkylating agent, an intercalating agent, an agent capable of interfering with a signal transduction pathway, an agent that promotes apoptosis or necrosis, and radiation.

25 In another embodiment, the compound is an activator of a 47508 polypeptide. Preferably, the activator is chosen from a peptide, a phosphopeptide, a small organic molecule, a small inorganic molecule, and an antibody. In another embodiment, the compound is an activator of a 47508 nucleic acid.

In another aspect, the invention features methods for treating or preventing a disorder 30 characterized by aberrant cellular proliferation or differentiation of a 47508-expressing cell, in a subject. Preferably, the method includes administering to the subject (e.g., a mammal, e.g., a human) an effective amount of a compound (e.g., a compound identified using the methods described herein) that modulates the activity, or expression, of the 47508

polypeptide or nucleic acid. In a preferred embodiment, the disorder is a cancerous or pre-cancerous condition.

In a further aspect, the invention provides methods for evaluating the efficacy of a treatment of a disorder, e.g., a proliferative disorder. The method includes: treating a subject, e.g., a patient or an animal, with a protocol under evaluation (e.g., treating a subject with one or more of: chemotherapy, radiation, and/or a compound identified using the methods described herein); and evaluating the expression of a 47508 nucleic acid or polypeptide before and after treatment. A change, e.g., a decrease or increase, in the level of a 47508 nucleic acid (e.g., mRNA) or polypeptide after treatment, relative to the level of expression before treatment, is indicative of the efficacy of the treatment of the disorder.

10 The level of 47508 nucleic acid or polypeptide expression can be detected by any method described herein.

In a preferred embodiment, the evaluating step includes obtaining a sample (e.g., a tissue sample, e.g., a biopsy, or a fluid sample) from the subject, before and after treatment and comparing the level of expressing of a 47508 nucleic acid (e.g., mRNA) or polypeptide before and after treatment.

In another aspect, the invention provides methods for evaluating the efficacy of a therapeutic or prophylactic agent (e.g., an anti-neoplastic agent). The method includes: contacting a sample with an agent (e.g., a compound identified using the methods described herein, or a cytotoxic agent) and, evaluating the expression of 47508 nucleic acid or polypeptide in the sample before and after the contacting step. A change, e.g., a decrease or increase, in the level of 47508 nucleic acid (e.g., mRNA) or polypeptide in the sample obtained after the contacting step, relative to the level of expression in the sample before the contacting step, is indicative of the efficacy of the agent. The level of 47508 nucleic acid or polypeptide expression can be detected by any method described herein. In a preferred embodiment, the sample includes cells obtained from a cancerous tissue, e.g., a cancerous breast, ovary, lung, colon, or liver tissue.

In further aspect, the invention provides assays for determining the presence or absence of a genetic alteration in a 47508 polypeptide or nucleic acid molecule, including 30 for disease diagnosis.

In another aspect, the invention features a two dimensional array having a plurality of addresses, each address of the plurality being positionally distinguishable from each other address of the plurality, and each address of the plurality having a unique capture probe,

e.g., a nucleic acid or peptide sequence. At least one address of the plurality has a capture probe that recognizes a 47508 molecule. In one embodiment, the capture probe is a nucleic acid, e.g., a probe complementary to a 47508 nucleic acid sequence. In another embodiment, the capture probe is a polypeptide, e.g., an antibody specific for 47508 polypeptides. Also featured is a method of analyzing a sample by contacting the sample to the aforementioned array and detecting binding of the sample to the array.

5 Other features and advantages of the invention will be apparent from the following detailed description, and from the claims.

Brief Description of the Drawings

10 *Figure 1* depicts a hydropathy plot of human 47508. Relative hydrophobic residues are shown above the dashed horizontal line, and relative hydrophilic residues are below the dashed horizontal line. Numbers corresponding to positions in the amino acid sequence of human 47508 are indicated. Polypeptides of the invention include fragments which include: all or part of a hydrophobic sequence, i.e., a sequence above the dashed line, e.g., the 15 sequence from about amino acid 151 to 172, from about 215 to 232, and from about 377 to 393 of SEQ ID NO:2; all or part of a hydrophilic sequence, i.e., a sequence below the dashed line, e.g., the sequence of from about amino acid 19 to 35, from about 245 to 263, and from about 286 to 310 of SEQ ID NO:2.

20 *Figure 2* depicts an alignment of the histone deacetylase domain of human 47508 with a consensus amino acid sequence derived from a hidden Markov model (HMM) from PFAM. The upper sequence is the consensus amino acid sequence (SEQ ID NO:4), while the lower amino acid sequence corresponds to amino acids 83 to 392 of SEQ ID NO:2.

25 *Figure 3A-3C* depict BLAST alignments of portions of the histone deacetylase domain of human 47508 with representative amino acid sequences derived from ProDomains No. 345193, 001400, and 021448 (ProDomain Release 2000.1; <http://www.toulouse.inra.fr/prodom.html>). The BLAST algorithm identifies multiple local alignments between the consensus amino acid sequence and human 47508. In Figure 3A, the lower sequence is the representative amino acid sequence of ProDomain 345193 (SEQ ID NO:5), while the upper amino acid sequence corresponds to an N-terminal portion of the 30 histone deacetylase domain of human 47508, about amino acid residues 71 to 115 of SEQ ID NO:2. In Figure 3B, the lower sequence is the representative amino acid sequence of ProDomain 001400 (SEQ ID NO:6), while the upper amino acid sequence corresponds to a

central portion of the histone deacetylase domain of human 47508, about amino acid residues 120 to 258. In Figure 3C, the lower sequence is the representative amino acid sequence of ProDomain 021448 (SEQ ID NO:7), while the upper amino acid sequence corresponds to a C-terminal portion of the histone deacetylase domain of human 47508,
5 about amino acid residues 251 to 372 of SEQ ID NO:2.

Detailed Description

The human 47508 sequence (see SEQ ID NO:1, as recited in Example 1), which is approximately 1579 nucleotides long including untranslated regions, contains a predicted
10 methionine-initiated coding sequence of about 1242 nucleotides, including the termination codon. The coding sequence encodes a 413 amino acid protein (see SEQ ID NO:2, as recited in Example 1).

Human 47508 contains the following regions or other structural features:

- 15 a histone deacetylase domain (PFAM accession number PF00850) located at about amino acid residues 83 to 392 of SEQ ID NO:2;
- 20 a histidine deacetylase zinc-binding triad having two conserved aspartic acid residues, located at about amino acid residues 247 and 327 of SEQ ID NO:2, and one conserved histidine residue, located at about amino acid residue 249 of SEQ ID NO:2;
- 25 a first charge-relay system formed by a conserved histidine residue, located at about amino acid residue 208 of SEQ ID NO:2, and a conserved aspartic acid residue, located at about amino acid residue 245 of SEQ ID NO:2;
- 30 a second charge-relay system formed by a conserved histidine residue, located at about amino acid residue 209 of SEQ ID NO:2, and a conservatively substituted asparagine residue, located at about amino acid residue 251 of SEQ ID NO:2.
- 25 four Protein Kinase C phosphorylation sites (PS00005) located at about amino acid residues 87 to 89, 142 to 144, 212 to 214, and 374 to 376 of SEQ ID NO:2;
- 35 five Casein Kinase II phosphorylation sites (PS00006) located at about amino acid residues 133 to 136, 157 to 160, 242 to 245, 295 to 298, and 311 to 314 of SEQ ID NO:2;
- 40 seven N-myristylation sites (PS00008) located at about amino acid residues 2 to 7, 37 to 42, 55 to 60, 66 to 71, 186 to 191, 215 to 220, and 237 to 242 of SEQ ID NO:2; and 45 one amidation site (PS00009) located at about amino acid residues 356 to 359.

For general information regarding PFAM identifiers, PS prefix and PF prefix domain identification numbers, refer to Sonnhammer *et al.* (1997) *Protein* 28:405-420 and <http://www.psc.edu/general/software/packages/pfam/pfam.html>.

A plasmid containing the nucleotide sequence encoding human 47508 (clone 5 "Fbh47508FL") was deposited with American Type Culture Collection (ATCC), 10801 University Boulevard, Manassas, VA 20110-2209, on _____ and assigned Accession Number _____. This deposit will be maintained under the terms of the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure. This deposit was made merely as a convenience for those of skill in the art and 10 is not an admission that a deposit is required under 35 U.S.C. §112.

The 47508 protein contains a significant number of structural characteristics in common with members of the histone deacetylase family. The term "family" when referring to the protein and nucleic acid molecules of the invention means two or more proteins or nucleic acid molecules having a common structural domain or motif and having sufficient 15 amino acid or nucleotide sequence homology as defined herein. Such family members can be naturally or non-naturally occurring and can be from either the same or different species. For example, a family can contain a first protein of human origin as well as other distinct proteins of human origin, or alternatively, can contain homologues of non-human origin, e.g., rat or mouse proteins. Members of a family can also have common functional 20 characteristics.

A histone deacetylase family of proteins is characterized by a common fold, which is a single domain open α/β fold. The fold consists of a central eight-stranded parallel β -sheet with four α -helices packed against each face of the β -sheet. There are an additional eight α -helices, most of which are clustered near one edge of the β -sheet. Together with loops that 25 arise from the carboxy-terminal ends of the β -strands of the β -sheet, the additional helices help form a deep, narrow pocket and an internal cavity adjacent to the pocket. At the bottom of the pocket, two aspartic acid residues and a histidine residue are involved in coordinating a zinc ion. The bottom of the pocket contains an additional five highly conserved residues, including two histidine residues, two aspartic acid residues, and a tyrosine residue. Each of 30 the histidine residues interacts with an aspartic acid residue, creating a charge-relay pair and thereby increasing the basicity of the imidazole $\text{N}\epsilon$ atom. It is believed that the substrate lysine residue, which is to be deacetylated, inserts into the pocket such that the acetylated end of the lysine residue coordinates with the zinc ion, and the aliphatic carbon atoms of the

lysine substrate form van der Waals contacts with conserved hydrophobic residues that line the wall of the pocket. Once the acetylated lysine residue is positioned correctly, the two histidine/aspartic acid charge-relay pairs help catalyze the removal of the acetyl group, giving rise to a deacetylated lysine residue and a free acetate molecule. The structure of a 5 histone deacetylase domain has been described, e.g., in Finnin *et al.* (1999), *Nature* 401(6749):188-93, the contents of which are incorporated herein by reference.

A 47508 polypeptide can include a "histone deacetylase domain" or regions homologous with a "histone deacetylase domain".

As used herein, the term "histone deacetylase domain" includes an amino acid 10 sequence of about 250 to 500 amino acid residues in length and having a bit score for the alignment of the sequence to the histone deacetylase domain profile (Pfam HMM) of at least 50. Preferably, a histone deacetylase domain includes at least about 275 to 450 amino acids, more preferably about 300 to 425 amino acid residues, or about 305 to 400 amino acids and has a bit score for the alignment of the sequence to the histone deacetylase domain (HMM) 15 of at least 75, 80, 82, 83, 84, or greater. The histone deacetylase domain (HMM) has been assigned the PFAM Accession Number PF00850 (<http://genome.wustl.edu/Pfam/.html>). An alignment of the histone deacetylase domain (amino acids 83 to 392 of SEQ ID NO:2) of human 47508 with a consensus amino acid sequence (SEQ ID NO:4) derived from a hidden Markov model is depicted in Figure 2.

20 In a preferred embodiment 47508 polypeptide or protein has a "histone deacetylase domain" or a region which includes at least about 250 to 500, more preferably about 275 to 450, or 305 to 400 amino acid residues and has at least about 50%, 60%, 70% 80% 90% 95%, 99%, or 100% homology with a "histone deacetylase domain," e.g., the histone deacetylase domain of human 47508 (e.g., residues 83 to 392 of SEQ ID NO:2).

25 To identify the presence of a "histone deacetylase" domain in a 47508 protein sequence, and make the determination that a polypeptide or protein of interest has a particular profile, the amino acid sequence of the protein can be searched against the Pfam database of HMMs (e.g., the Pfam database, release 2.1) using the default parameters (http://www.sanger.ac.uk/Software/Pfam/HMM_search). For example, the hmmsf program, 30 which is available as part of the HMMER package of search programs, is a family specific default program for MILPAT0063 and a score of 15 is the default threshold score for determining a hit. Alternatively, the threshold score for determining a hit can be lowered (e.g., to 8 bits). A description of the Pfam database can be found in Sonhammer *et al.*

(1997) *Proteins* 28(3):405-420 and a detailed description of HMMs can be found, for example, in Gribskov *et al.* (1990) *Meth. Enzymol.* 183:146-159; Gribskov *et al.* (1987) *Proc. Natl. Acad. Sci. USA* 84:4355-4358; Krogh *et al.* (1994) *J. Mol. Biol.* 235:1501-1531; and Stultz *et al.* (1993) *Protein Sci.* 2:305-314, the contents of which are incorporated herein by reference. A search was performed against the HMM database resulting in the identification of a "histone deacetylase" domain in the amino acid sequence of human 47508 at about residues 83 to 392 of SEQ ID NO:2 (see Figure 2).

Alternatively, to identify the presence of a "histone deacetylase" domain in a 47508 protein sequence, and make the determination that a polypeptide or protein of interest has a particular profile, the amino acid sequence of the protein can be searched against a database of domains, e.g., the ProDom database (Corpet *et al.* (1999), *Nucl. Acids Res.* 27:263-267) The ProDom protein domain database consists of an automatic compilation of homologous domains. Current versions of ProDom are built using recursive PSI-BLAST searches (Altschul SF *et al.* (1997) *Nucleic Acids Res.* 25:3389-3402; Gouzy *et al.* (1999) *Computers and Chemistry* 23:333-340.) of the SWISS-PROT 38 and TREMBL protein databases. The database automatically generates a consensus sequence for each domain. A BLAST search was performed against the ProDom database resulting in the identification of three portions of a "histone deacetylase" domain in the amino acid sequence of human 47508, located at about residues 71 to 115, 120 to 258, and 251 to 371 of SEQ ID NO:2 (see Figures 3A-3C). Taken together, the three portions of a histone deacetylase domain which were identified in human 47508, by blasting the 47508 sequence against the ProDomain database, constitute a domain that has similar length and endpoints (about amino acid residues 71 to 372 of SEQ ID NO:2) as the histone deacetylase domain identified in human 47508 by searching the PFAM database (about amino acid residues 83 to 392 of SEQ ID NO:2). Furthermore, functionally important amino acid residues (described below) that display conservation in the PFAM alignment (see Figure 2) display similar conservation in the ProDomain alignments (see Figure 3A-C), and the bit score for two of the three ProDomain alignments (Figures 3A and 3C, with bit scores of 85.3 and 143.8, respectively) actually exceeds the bit score for the PFAM alignment (Figure 2, with a bit score of 84.6).

In one embodiment, a 47508 protein includes at least one histone deacetylase zinc-binding triad. As used herein, a "histone deacetylase zinc-binding triad" includes two conserved aspartic acid residues and a conserved histidine residue located at the bottom of the substrate-binding pocket of a histone deacetylase domain. A "histone deacetylase zinc-

binding triad", as defined, can be involved in the coordination of an ion, e.g., a zinc or cobalt ion, and through said ion, in the interaction with an acetylated lysine substrate. Histone deacetylase zinc-binding triads have been described in Finnin *et al.* (1999), *supra*, the contents of which are incorporated herein by reference.

5 In a preferred embodiment, a 47508 polypeptide or protein has at least one histone deacetylase zinc-binding triad, or a sequence in which not more than one of the two aspartic acid residues is conservatively substituted, e.g., substituted with asparagine, glutamic acid, or glutamine, while the other aspartic acid residue and the histidine residue are absolutely conserved. The residues of human 47508 that constitute the histone deacetylase zinc-
10 binding triad are the aspartic acid residues located at about amino acid residues 247 and 327 of SEQ ID NO:2 and the histidine residue located at about amino acid residue 249 of SEQ ID NO:2.

In another embodiment, a 47508 protein includes at least two charge-relay systems. As used herein, a "charge-relay system" includes a conserved histidine residue and either an 15 aspartic acid residue or an asparagine residue, which interact with one another such that the imidazole N ϵ atom of the histidine residue has an increased basicity, and the two residues are located at the bottom of the substrate binding pocket of a histone deacetylase domain. A "charge-relay system", as defined, can be involved in the enzymatic deacetylation of an 20 acetylated lysine residue. Charge-relay systems, as found in histone deacetylases, have been described in Finnin *et al.* (1999), *supra*, the contents of which are incorporated herein by reference.

In a preferred embodiment, a 47508 polypeptide or protein includes at least two charge-relay systems, or at least two conserved histidine residues that each interact with a 25 second amino acid residue selected from the group of aspartic acid, asparagines, glutamine, and glutamic acid, whereby the imidazole N ϵ atom of the histidine residue has an increased basicity. The residues of human 47508 that constitute the two charge-relay systems are: 1) the histidine residue located at about amino acid residue 208 of SEQ ID NO:2 and the aspartic acid residue located at about amino acid residue 247 of SEQ ID NO:2; and 2) the histidine residue located at about amino acid residue 209 of SEQ ID NO:2 and the 30 asparagine residue located at about amino acid residue 252 of SEQ ID NO:2.

A 47508 family member can include at least one histone deacetylase domain. Furthermore, a 47508 family member can include at least one histone deacetylase zinc-binding triad; at least two charge-relay systems; at least one, two, three, preferably four

predicted protein kinase C phosphorylation sites (PS00005); at least one, two, three, four, and preferably five predicted casein kinase II phosphorylation sites (PS00006); at least one, two, three, four, five, six, and preferably seven predicted N-myristylation sites (PS00008); and at least one predicted amidation site (PS00009).

5 As the 47508 polypeptides of the invention may modulate 47508-mediated activities, they may be useful as of for developing novel diagnostic and therapeutic agents for 47508-mediated or related disorders, as described below.

As used herein, a "47508 activity", "biological activity of 47508" or "functional activity of 47508", refers to an activity exerted by a 47508 protein, polypeptide or nucleic acid molecule. For example, a 47508 activity can be an activity exerted by 47508 in a physiological milieu on, e.g., a 47508-responsive cell or on a 47508 substrate, e.g., a protein substrate. A 47508 activity can be determined *in vivo* or *in vitro*. In one embodiment, a 47508 activity is a direct activity, such as an association with a 47508 target molecule. A "target molecule" or "binding partner" is a molecule with which a 47508 protein binds or 10 interacts in nature. In an exemplary embodiment, 47508 is an enzyme for that catalyzes the removal of an acetyl group from an acetylated lysine residue of a substrate protein, e.g., a histone protein, e.g., H2A, H2B, H3, or H4.

A 47508 activity can also be an indirect activity, e.g., a cellular signaling activity mediated by interaction of the 47508 protein with a 47508 receptor. The features of the 20 47508 molecules of the present invention can provide similar biological activities as histone deacetylase family members. For example, the 47508 proteins of the present invention can have one or more of the following activities: (1) catalytic removal of acetyl groups from proteins, e.g., histones, e.g., histone H2A, H2B, H3, or H4; (2) catalytic removal of acetyl groups from lysine residues present in proteins, e.g., histones, e.g., histone H2A, H2B, H3, 25 or H4; (3) regulation of the association of histones with DNA; (4) regulation of chromosomal condensation; (5) interaction with transcription factors, e.g., transcriptional repressors; (6) regulation of transcription, e.g., transcriptional repression; (7) regulation of cellular differentiation, e.g., suppression or induction of cellular differentiation; (8) regulation of the cell cycle, e.g., cell-cycle progression or arrest; (9) regulation of tumor 30 growth; (10) localizes to the nucleus; and (11) can be inhibited by histone deacetylase inhibitors, e.g., sodium butyrate, tricostatin, suberoylanilide hydroxamic acid, MS-27-275, or FR901228.

Thus, the 47508 molecules can act as novel diagnostic targets and therapeutic agents for controlling cellular proliferative and/or differentiative disorders, as well as disorders of the breast, ovary, lung, colon, or liver, and cardiovascular disorders.

The 47508 molecules can act as novel diagnostic targets and therapeutic agents for 5 controlling one or more of cellular proliferative and/or differentiative disorders, disorders associated with bone metabolism, immune disorders (e.g., inflammatory disorders), cardiovascular disorders, liver disorders, viral diseases, pain or metabolic disorders.

Examples of cellular proliferative and/or differentiative disorders include cancer, e.g., carcinoma, sarcoma, metastatic disorders or hematopoietic neoplastic disorders, e.g., 10 leukemias. A metastatic tumor can arise from a multitude of primary tumor types, including but not limited to those of prostate, colon, lung, breast and liver origin.

As used herein, the terms "cancer", "hyperproliferative" and "neoplastic" refer to 15 cells having the capacity for autonomous growth. Examples of such cells include cells having an abnormal state or condition characterized by rapidly proliferating cell growth. Hyperproliferative and neoplastic disease states may be categorized as pathologic, i.e., characterizing or constituting a disease state, or may be categorized as non-pathologic, i.e., a deviation from normal but not associated with a disease state. The term is meant to include 20 all types of cancerous growths or oncogenic processes, metastatic tissues or malignantly transformed cells, tissues, or organs, irrespective of histopathologic type or stage of invasiveness. "Pathologic hyperproliferative" cells occur in disease states characterized by malignant tumor growth. Examples of non-pathologic hyperproliferative cells include proliferation of cells associated with wound repair.

The terms "cancer" or "neoplasms" include malignancies of the various organ 25 systems, such as affecting lung, breast, thyroid, lymphoid, gastrointestinal, and genito-urinary tract, as well as adenocarcinomas which include malignancies such as most colon cancers, renal-cell carcinoma, prostate cancer and/or testicular tumors, non-small cell carcinoma of the lung, cancer of the small intestine and cancer of the esophagus.

The term "carcinoma" is art recognized and refers to malignancies of epithelial or 30 endocrine tissues including respiratory system carcinomas, gastrointestinal system carcinomas, genitourinary system carcinomas, testicular carcinomas, breast carcinomas, prostatic carcinomas, endocrine system carcinomas, and melanomas. Exemplary carcinomas include those forming from tissue of the cervix, lung, prostate, breast, head and neck, colon and ovary. The term also includes carcinosarcomas, e.g., which include malignant tumors

composed of carcinomatous and sarcomatous tissues. An "adenocarcinoma" refers to a carcinoma derived from glandular tissue or in which the tumor cells form recognizable glandular structures.

5 The term "sarcoma" is art recognized and refers to malignant tumors of mesenchymal derivation.

Examples of cellular proliferative and/or differentiative disorders of the colon include, but are not limited to, non-neoplastic polyps, adenomas, familial syndromes, colorectal carcinogenesis, colorectal carcinoma, and carcinoid tumors.

10 Examples of cellular proliferative and/or differentiative disorders of the liver include, but are not limited to, nodular hyperplasias, adenomas, and malignant tumors, including primary carcinoma of the liver and metastatic tumors.

15 Examples of cellular proliferative and/or differentiative disorders of the breast include, but are not limited to, proliferative breast disease including, e.g., epithelial hyperplasia, sclerosing adenosis, and small duct papillomas; tumors, e.g., stromal tumors such as fibroadenoma, phyllodes tumor, and sarcomas, and epithelial tumors such as large duct papilloma; carcinoma of the breast including in situ (noninvasive) carcinoma that includes ductal carcinoma in situ (including Paget's disease) and lobular carcinoma in situ, and invasive (infiltrating) carcinoma including, but not limited to, invasive ductal carcinoma, invasive lobular carcinoma, medullary carcinoma, colloid (mucinous) carcinoma, tubular carcinoma, and invasive papillary carcinoma, and miscellaneous malignant neoplasms. Disorders in the male breast include, but are not limited to, gynecomastia and carcinoma.

20 Examples of cellular proliferative and/or differentiative disorders of the lung include, but are not limited to, bronchogenic carcinoma, including paraneoplastic syndromes, bronchioloalveolar carcinoma, neuroendocrine tumors, such as bronchial carcinoid, miscellaneous tumors, and metastatic tumors; pathologies of the pleura, including inflammatory pleural effusions, noninflammatory pleural effusions, pneumothorax, and pleural tumors, including solitary fibrous tumors (pleural fibroma) and malignant mesothelioma.

30 Additional examples of proliferative disorders include hematopoietic neoplastic disorders. As used herein, the term "hematopoietic neoplastic disorders" includes diseases involving hyperplastic/neoplastic cells of hematopoietic origin. A hematopoietic neoplastic disorder can arise from myeloid, lymphoid or erythroid lineages, or precursor cells thereof.

Preferably, the diseases arise from poorly differentiated acute leukemias, e.g., erythroblastic leukemia and acute megakaryoblastic leukemia. Additional exemplary myeloid disorders include, but are not limited to, acute promyeloid leukemia (APML), acute myelogenous leukemia (AML) and chronic myelogenous leukemia (CML) (reviewed in Vaickus, L. 5 (1991) *Crit Rev. in Oncol./Hemotol.* 11:267-97); lymphoid malignancies include, but are not limited to acute lymphoblastic leukemia (ALL) which includes B-lineage ALL and T-lineage ALL, chronic lymphocytic leukemia (CLL), prolymphocytic leukemia (PLL), hairy cell leukemia (HLL) and Waldenstrom's macroglobulinemia (WM). Additional forms of malignant lymphomas include, but are not limited to non-Hodgkin lymphoma and variants 10 thereof, peripheral T cell lymphomas, adult T cell leukemia/lymphoma (ATL), cutaneous T-cell lymphoma (CTCL), large granular lymphocytic leukemia (LGF), Hodgkin's disease and Reed-Sternberg disease.

Disorders of the breast include, but are not limited to, disorders of development; inflammations, including but not limited to, acute mastitis, periductal mastitis, periductal 15 mastitis (recurrent subareolar abscess, squamous metaplasia of lactiferous ducts), mammary duct ectasia, fat necrosis, granulomatous mastitis, and pathologies associated with silicone breast implants; fibrocystic changes; proliferative breast disease including, but not limited to, epithelial hyperplasia, sclerosing adenosis, and small duct papillomas; tumors including, but not limited to, stromal tumors such as fibroadenoma, phyllodes tumor, and sarcomas, 20 and epithelial tumors such as large duct papilloma; carcinoma of the breast including in situ (noninvasive) carcinoma that includes ductal carcinoma in situ (including Paget's disease) and lobular carcinoma in situ, and invasive (infiltrating) carcinoma including, but not limited to, invasive ductal carcinoma, no special type, invasive lobular carcinoma, medullary carcinoma, colloid (mucinous) carcinoma, tubular carcinoma, and invasive papillary 25 carcinoma, and miscellaneous malignant neoplasms. Disorders in the male breast include, but are not limited to, gynecomastia and carcinoma.

Disorders involving the ovary include, for example, polycystic ovarian disease, Stein-Leventhal syndrome, Pseudomyxoma peritonei and stromal hyperthecosis; ovarian tumors such as, tumors of coelomic epithelium, serous tumors, mucinous tumors, 30 endometrioid tumors, clear cell adenocarcinoma, cystadenofibroma, Brenner tumor, surface epithelial tumors; germ cell tumors such as mature (benign) teratomas, monodermal teratomas, immature malignant teratomas, dysgerminoma, endodermal sinus tumor, choriocarcinoma; sex cord-stromal tumors such as, granulosa-theca cell tumors, thecoma-

fibromas, androblastomas, hillock cell tumors, and gonadoblastoma; and metastatic tumors such as Krukenberg tumors.

Examples of disorders of the lung include, but are not limited to, congenital anomalies; atelectasis; diseases of vascular origin, such as pulmonary congestion and edema, 5 including hemodynamic pulmonary edema and edema caused by microvascular injury, adult respiratory distress syndrome (diffuse alveolar damage), pulmonary embolism, hemorrhage, and infarction, and pulmonary hypertension and vascular sclerosis; chronic obstructive pulmonary disease, such as emphysema, chronic bronchitis, bronchial asthma, and bronchiectasis; diffuse interstitial (infiltrative, restrictive) diseases, such as pneumoconioses, 10 sarcoidosis, idiopathic pulmonary fibrosis, desquamative interstitial pneumonitis, hypersensitivity pneumonitis, pulmonary eosinophilia (pulmonary infiltration with eosinophilia), *Bronchiolitis obliterans*-organizing pneumonia, diffuse pulmonary hemorrhage syndromes, including Goodpasture syndrome, idiopathic pulmonary hemosiderosis and other hemorrhagic syndromes, pulmonary involvement in collagen 15 vascular disorders, and pulmonary alveolar proteinosis; complications of therapies, such as drug-induced lung disease, radiation-induced lung disease, and lung transplantation; tumors, such as bronchogenic carcinoma, including paraneoplastic syndromes, bronchioloalveolar carcinoma, neuroendocrine tumors, such as bronchial carcinoid, miscellaneous tumors, and metastatic tumors; pathologies of the pleura, including inflammatory pleural effusions, 20 noninflammatory pleural effusions, pneumothorax, and pleural tumors, including solitary fibrous tumors (pleural fibroma) and malignant mesothelioma.

Disorders involving the colon include, but are not limited to, congenital anomalies, such as atresia and stenosis, Meckel diverticulum, congenital aganglionic megacolon-Hirschsprung disease; enterocolitis, such as diarrhea and dysentery, infectious enterocolitis, 25 including viral gastroenteritis, bacterial enterocolitis, necrotizing enterocolitis, antibiotic-associated colitis (pseudomembranous colitis), and collagenous and lymphocytic colitis, miscellaneous intestinal inflammatory disorders, including parasites and protozoa, acquired immunodeficiency syndrome, transplantation, drug-induced intestinal injury, radiation enterocolitis, neutropenic colitis (typhlitis), and diversion colitis; idiopathic inflammatory 30 bowel disease, such as Crohn disease and ulcerative colitis; tumors of the colon, such as non-neoplastic polyps, adenomas, familial syndromes, colorectal carcinogenesis, colorectal carcinoma, and carcinoid tumors.

The 47508 protein, fragments thereof, and derivatives and other variants of the sequence in SEQ ID NO:2 thereof are collectively referred to as "polypeptides or proteins of the invention" or "47508 polypeptides or proteins". Nucleic acid molecules encoding such polypeptides or proteins are collectively referred to as "nucleic acids of the invention" or 5 "47508 nucleic acids." 47508 molecules refer to 47508 nucleic acids, polypeptides, and antibodies.

As used herein, the term "nucleic acid molecule" includes DNA molecules (e.g., a cDNA or genomic DNA), RNA molecules (e.g., an mRNA) and analogs of the DNA or RNA. A DNA or RNA analog can be synthesized from nucleotide analogs. The nucleic 10 acid molecule can be single-stranded or double-stranded, but preferably is double-stranded DNA.

The term "isolated nucleic acid molecule" or "purified nucleic acid molecule" includes nucleic acid molecules that are separated from other nucleic acid molecules present in the natural source of the nucleic acid. For example, with regards to genomic DNA, the 15 term "isolated" includes nucleic acid molecules which are separated from the chromosome with which the genomic DNA is naturally associated. Preferably, an "isolated" nucleic acid is free of sequences which naturally flank the nucleic acid (i.e., sequences located at the 5' and/or 3' ends of the nucleic acid) in the genomic DNA of the organism from which the nucleic acid is derived. For example, in various embodiments, the isolated nucleic acid 20 molecule can contain less than about 5 kb, 4 kb, 3 kb, 2 kb, 1 kb, 0.5 kb or 0.1 kb of 5' and/or 3' nucleotide sequences which naturally flank the nucleic acid molecule in genomic DNA of the cell from which the nucleic acid is derived. Moreover, an "isolated" nucleic acid molecule, such as a cDNA molecule, can be substantially free of other cellular material, 25 or culture medium when produced by recombinant techniques, or substantially free of chemical precursors or other chemicals when chemically synthesized.

As used herein, the term "hybridizes under low stringency, medium stringency, high stringency, or very high stringency conditions" describes conditions for hybridization and washing. Guidance for performing hybridization reactions can be found in *Current Protocols in Molecular Biology*, John Wiley & Sons, N.Y. (1989), 6.3.1-6.3.6, which is 30 incorporated by reference. Aqueous and nonaqueous methods are described in that reference and either can be used. Specific hybridization conditions referred to herein are as follows: 1) low stringency hybridization conditions in 6X sodium chloride/sodium citrate (SSC) at about 45°C, followed by two washes in 0.2X SSC, 0.1% SDS at least at 50°C (the

temperature of the washes can be increased to 55°C for low stringency conditions); 2) medium stringency hybridization conditions in 6X SSC at about 45°C, followed by one or more washes in 0.2X SSC, 0.1% SDS at 60°C; 3) high stringency hybridization conditions in 6X SSC at about 45°C, followed by one or more washes in 0.2X SSC, 0.1% SDS at 65°C; 5 and preferably 4) very high stringency hybridization conditions are 0.5M sodium phosphate, 7% SDS at 65°C, followed by one or more washes at 0.2X SSC, 1% SDS at 65°C. Very high stringency conditions (4) are the preferred conditions and the ones that should be used unless otherwise specified.

Preferably, an isolated nucleic acid molecule of the invention that hybridizes under a 10 stringency condition described herein to the sequence of SEQ ID NO:1 or SEQ ID NO:3, corresponds to a naturally-occurring nucleic acid molecule.

As used herein, a "naturally-occurring" nucleic acid molecule refers to an RNA or DNA molecule having a nucleotide sequence that occurs in nature. For example a naturally occurring nucleic acid molecule can encode a natural protein.

15 As used herein, the terms "gene" and "recombinant gene" refer to nucleic acid molecules which include at least an open reading frame encoding a 47508 protein. The gene can optionally further include non-coding sequences, e.g., regulatory sequences and introns. Preferably, a gene encodes a mammalian 47508 protein or derivative thereof.

An "isolated" or "purified" polypeptide or protein is substantially free of cellular 20 material or other contaminating proteins from the cell or tissue source from which the protein is derived, or substantially free from chemical precursors or other chemicals when chemically synthesized. "Substantially free" means that a preparation of 47508 protein is at least 10% pure. In a preferred embodiment, the preparation of 47508 protein has less than about 30%, 20%, 10% and more preferably 5% (by dry weight), of non-47508 protein (also 25 referred to herein as a "contaminating protein"), or of chemical precursors or non-47508 chemicals. When the 47508 protein or biologically active portion thereof is recombinantly produced, it is also preferably substantially free of culture medium, i.e., culture medium represents less than about 20%, more preferably less than about 10%, and most preferably less than about 5% of the volume of the protein preparation. The invention includes isolated 30 or purified preparations of at least 0.01, 0.1, 1.0, and 10 milligrams in dry weight.

A "non-essential" amino acid residue is a residue that can be altered from the wild-type sequence of 47508 without abolishing or substantially altering a 47508 activity.

Preferably the alteration does not substantially alter the 47508 activity, e.g., the activity is at

least 20%, 40%, 60%, 70% or 80% of wild-type. An "essential" amino acid residue is a residue that, when altered from the wild-type sequence of 47508, results in abolishing a 47508 activity such that less than 20% of the wild-type activity is present. For example, conserved amino acid residues in 47508 are predicted to be particularly unamenable to alteration.

A "conservative amino acid substitution" is one in which the amino acid residue is replaced with an amino acid residue having a similar side chain. Families of amino acid residues having similar side chains have been defined in the art. These families include amino acids with basic side chains (e.g., lysine, arginine, histidine), acidic side chains (e.g., 10 aspartic acid, glutamic acid), uncharged polar side chains (e.g., glycine, asparagine, glutamine, serine, threonine, tyrosine, cysteine), nonpolar side chains (e.g., alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan), beta-branched side chains (e.g., threonine, valine, isoleucine) and aromatic side chains (e.g., tyrosine, phenylalanine, tryptophan, histidine). Thus, a predicted nonessential amino acid residue in a 15 47508 protein is preferably replaced with another amino acid residue from the same side chain family. Alternatively, in another embodiment, mutations can be introduced randomly along all or part of a 47508 coding sequence, such as by saturation mutagenesis, and the resultant mutants can be screened for 47508 biological activity to identify mutants that retain activity. Following mutagenesis of SEQ ID NO:1 or SEQ ID NO:3, the encoded protein can 20 be expressed recombinantly and the activity of the protein can be determined.

As used herein, a "biologically active portion" of a 47508 protein includes a fragment of a 47508 protein which participates in an interaction, e.g., an intramolecular or an inter-molecular interaction. An inter-molecular interaction can be a specific binding interaction or an enzymatic interaction (e.g., the interaction can be transient and a covalent 25 bond is formed or broken). An inter-molecular interaction can be between a 47508 molecule and a non-47508 molecule or between a first 47508 molecule and a second 47508 molecule (e.g., a dimerization interaction). Biologically active portions of a 47508 protein include peptides comprising amino acid sequences sufficiently homologous to or derived from the amino acid sequence of the 47508 protein, e.g., the amino acid sequence shown in SEQ ID 30 NO:2, which include less amino acids than the full length 47508 proteins, and exhibit at least one activity of a 47508 protein. Typically, biologically active portions comprise a domain or motif with at least one activity of the 47508 protein, e.g., histone deacetylation, e.g., deacetylation of histone H2A, H2B, H3, or H4. A biologically active portion of a

47508 protein can be a polypeptide which is, for example, 10, 25, 50, 100, 200 or more amino acids in length. Biologically active portions of a 47508 protein can be used as targets for developing agents which modulate a 47508 mediated activity, e.g., histone deacetylation, e.g., deacetylation of histone H2A, H2B, H3, or H4.

5 Calculations of homology or sequence identity between sequences (the terms are used interchangeably herein) are performed as follows.

To determine the percent identity of two amino acid sequences, or of two nucleic acid sequences, the sequences are aligned for optimal comparison purposes (e.g., gaps can be introduced in one or both of a first and a second amino acid or nucleic acid sequence for 10 optimal alignment and non-homologous sequences can be disregarded for comparison purposes). In a preferred embodiment, the length of a reference sequence aligned for comparison purposes is at least 30%, preferably at least 40%, more preferably at least 50%, 60%, and even more preferably at least 70%, 80%, 90%, 100% of the length of the reference sequence. The amino acid residues or nucleotides at corresponding amino acid positions or 15 nucleotide positions are then compared. When a position in the first sequence is occupied by the same amino acid residue or nucleotide as the corresponding position in the second sequence, then the molecules are identical at that position (as used herein amino acid or nucleic acid "identity" is equivalent to amino acid or nucleic acid "homology").

The percent identity between the two sequences is a function of the number of 20 identical positions shared by the sequences, taking into account the number of gaps, and the length of each gap, which need to be introduced for optimal alignment of the two sequences.

The comparison of sequences and determination of percent identity between two sequences can be accomplished using a mathematical algorithm. In a preferred embodiment, the percent identity between two amino acid sequences is determined using the 25 Needleman and Wunsch ((1970) *J. Mol. Biol.* 48:444-453) algorithm which has been incorporated into the GAP program in the GCG software package (available at <http://www.gcg.com>), using either a Blossum 62 matrix or a PAM250 matrix, and a gap weight of 16, 14, 12, 10, 8, 6, or 4 and a length weight of 1, 2, 3, 4, 5, or 6. In yet another preferred embodiment, the percent identity between two nucleotide sequences is determined 30 using the GAP program in the GCG software package (available at <http://www.gcg.com>), using a NWSgapdna.CMP matrix and a gap weight of 40, 50, 60, 70, or 80 and a length weight of 1, 2, 3, 4, 5, or 6. A particularly preferred set of parameters (and the one that

should be used unless otherwise specified) are a Blossum 62 scoring matrix with a gap penalty of 12, a gap extend penalty of 4, and a frameshift gap penalty of 5.

The percent identity between two amino acid or nucleotide sequences can be determined using the algorithm of E. Meyers and W. Miller ((1989) CABIOS, 4:11-17) 5 which has been incorporated into the ALIGN program (version 2.0), using a PAM120 weight residue table, a gap length penalty of 12 and a gap penalty of 4.

The nucleic acid and protein sequences described herein can be used as a "query sequence" to perform a search against public databases to, for example, identify other family members or related sequences. Such searches can be performed using the NBLAST and 10 XBLAST programs (version 2.0) of Altschul, *et al.* (1990) *J. Mol. Biol.* 215:403-10.

BLAST nucleotide searches can be performed with the NBLAST program, score = 100, wordlength = 12 to obtain nucleotide sequences homologous to 47508 nucleic acid molecules of the invention. BLAST protein searches can be performed with the XBLAST program, score = 50, wordlength = 3 to obtain amino acid sequences homologous to 47508 15 protein molecules of the invention. To obtain gapped alignments for comparison purposes, Gapped BLAST can be utilized as described in Altschul *et al.*, (1997) *Nucleic Acids Res.* 25:3389-3402. When utilizing BLAST and Gapped BLAST programs, the default parameters of the respective programs (e.g., XBLAST and NBLAST) can be used. See <http://www.ncbi.nlm.nih.gov>.

20 Particularly preferred 47508 polypeptides of the present invention have an amino acid sequence substantially identical to the amino acid sequence of SEQ ID NO:2. In the context of an amino acid sequence, the term "substantially identical" is used herein to refer to a first amino acid that contains a sufficient or minimum number of amino acid residues that are i) identical to, or ii) conservative substitutions of aligned amino acid residues in a 25 second amino acid sequence such that the first and second amino acid sequences can have a common structural domain and/or common functional activity. For example, amino acid sequences that contain a common structural domain having at least about 60%, or 65% identity, likely 75% identity, more likely 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98% or 99% identity to SEQ ID NO:2 are termed substantially identical.

30 In the context of nucleotide sequence, the term "substantially identical" is used herein to refer to a first nucleic acid sequence that contains a sufficient or minimum number of nucleotides that are identical to aligned nucleotides in a second nucleic acid sequence such that the first and second nucleotide sequences encode a polypeptide having common

functional activity, or encode a common structural polypeptide domain or a common functional polypeptide activity. For example, nucleotide sequences having at least about 60%, or 65% identity, likely 75% identity, more likely 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98% or 99% identity to SEQ ID NO:1 or 3 are termed substantially identical.

5 "Misexpression or aberrant expression", as used herein, refers to a non-wildtype pattern of gene expression at the RNA or protein level. It includes: expression at non-wild type levels, i.e., over- or under-expression; a pattern of expression that differs from wild type in terms of the time or stage at which the gene is expressed, e.g., increased or decreased expression (as compared with wild type) at a predetermined developmental period or stage; a pattern of expression that differs from wild type in terms of altered, e.g., increased or decreased, expression (as compared with wild type) in a predetermined cell type or tissue type; a pattern of expression that differs from wild type in terms of the splicing size, translated amino acid sequence, post-transitional modification, or biological activity of the 10 expressed polypeptide; a pattern of expression that differs from wild type in terms of the effect of an environmental stimulus or extracellular stimulus on expression of the gene, e.g., a pattern of increased or decreased expression (as compared with wild type) in the presence 15 of an increase or decrease in the strength of the stimulus.

"Subject," as used herein, refers to human and non-human animals. The term "non-human animals" of the invention includes all vertebrates, e.g., mammals, such as non-human primates (particularly higher primates), sheep, dog, rodent (e.g., mouse or rat), guinea pig, goat, pig, cat, rabbits, cow, and non-mammals, such as chickens, amphibians, reptiles, etc. In a preferred embodiment, the subject is a human. In another embodiment, the subject is an experimental animal or animal suitable as a disease model.

25 A "purified preparation of cells", as used herein, refers to an in vitro preparation of cells. In the case cells from multicellular organisms (e.g., plants and animals), a purified preparation of cells is a subset of cells obtained from the organism, not the entire intact organism. In the case of unicellular microorganisms (e.g., cultured cells and microbial cells), it consists of a preparation of at least 10% and more preferably 50% of the subject 30 cells.

Various aspects of the invention are described in further detail below.

Isolated Nucleic Acid Molecules

In one aspect, the invention provides, an isolated or purified, nucleic acid molecule that encodes a 47508 polypeptide described herein, e.g., a full-length 47508 protein or a fragment thereof, e.g., a biologically active portion of 47508 protein. Also included is a 5 nucleic acid fragment suitable for use as a hybridization probe, which can be used, e.g., to identify a nucleic acid molecule encoding a polypeptide of the invention, 47508 mRNA, and fragments suitable for use as primers, e.g., PCR primers for the amplification or mutation of nucleic acid molecules.

In one embodiment, an isolated nucleic acid molecule of the invention includes the 10 nucleotide sequence shown in SEQ ID NO:1, or a portion of any of these nucleotide sequences. In one embodiment, the nucleic acid molecule includes sequences encoding the human 47508 protein (i.e., "the coding region" of SEQ ID NO:1, as shown in SEQ ID NO:3), as well as 5' untranslated sequences. Alternatively, the nucleic acid molecule can include only the coding region of SEQ ID NO:1 (e.g., SEQ ID NO:3) and, e.g., no flanking 15 sequences which normally accompany the subject sequence. In yet another embodiment, the nucleic acid includes one or more nucleotides from 1-234 or 852-862 of SEQ ID NO:1. In another embodiment, the nucleic acid molecule encodes a sequence corresponding to a fragment of the protein from about amino acid 8 to 392 of SEQ ID NO:2. In other embodiments, the nucleic acid molecule includes a nucleotide sequence encoding one or 20 more of amino acids 1-57 or 263-266 of SEQ ID NO:2.

In another embodiment, an isolated nucleic acid molecule of the invention includes a nucleic acid molecule which is a complement of the nucleotide sequence shown in SEQ ID NO:1 or SEQ ID NO:3, or a portion of any of these nucleotide sequences. In other embodiments, the nucleic acid molecule of the invention is sufficiently complementary to 25 the nucleotide sequence shown in SEQ ID NO:1 or SEQ ID NO:3, such that it can hybridize (e.g., under a stringency condition described herein) to the nucleotide sequence shown in SEQ ID NO:1 or 3, thereby forming a stable duplex.

In one embodiment, an isolated nucleic acid molecule of the present invention includes a nucleotide sequence which is at least about: 75%, 80%, 85%, 90%, 91%, 92%, 30 93%, 94%, 95%, 96%, 97%, 98%, 99%, or more homologous to the entire length of the nucleotide sequence shown in SEQ ID NO:1 or SEQ ID NO:3, or a portion, preferably of the same length, of any of these nucleotide sequences.

47508 Nucleic Acid Fragments

A nucleic acid molecule of the invention can include only a portion of the nucleic acid sequence of SEQ ID NO:1 or 3. For example, such a nucleic acid molecule can include a fragment which can be used as a probe or primer or a fragment encoding a portion of a 5 47508 protein, e.g., an immunogenic or biologically active portion of a 47508 protein. A fragment can comprise those nucleotides of SEQ ID NO:1 (e.g., one or more of nucleotides 1-234 of SEQ ID NO:1), which encode the N-terminus of 47508, e.g., about amino acid residues 1 to 57 of SEQ ID NO:2, or a portion thereof. Alternatively, a fragment can comprise those nucleotides of SEQ ID NO:1 which encode amino acids 263 to 266 of SEQ 10 ID NO:2 (e.g., nucleotides 852-862 of SEQ ID NO:1). The nucleotide sequence determined from the cloning of the 47508 gene allows for the generation of probes and primers designed for use in identifying and/or cloning other 47508 family members, or fragments thereof, as well as 47508 homologues, or fragments thereof, from other species.

In another embodiment, a nucleic acid includes a nucleotide sequence that includes 15 part, or all, of the coding region and extends into either (or both) the 5' or 3' noncoding region. Other embodiments include a fragment which includes a nucleotide sequence encoding an amino acid fragment described herein. Nucleic acid fragments can encode a specific domain or site described herein or fragments thereof, particularly fragments thereof which are at least 100, 200, 220, 240, 250, 275, 300, 320, or more amino acids in length. Fragments also include 20 nucleic acid sequences corresponding to specific amino acid sequences described above or fragments thereof. Nucleic acid fragments should not to be construed as encompassing those fragments that may have been disclosed prior to the invention, e.g., SEQ ID NO:4375 of WO 00/58473, SEQ ID NOS: 2079 and 2462 of WO 01/02568, or sequences having NCBI accession numbers AL137362 or AU079696.

25 A nucleic acid fragment can include a sequence corresponding to a domain, region, or functional site described herein. A nucleic acid fragment can also include one or more domain, region, or functional site described herein. Thus, for example, a 47508 nucleic acid fragment can include a sequence corresponding to a histone deacetylase domain, e.g., about amino acid residues 83 to 392 of SEQ ID NO:2 (or a fragment thereof, e.g., amino acids 83-150, 150-200, 30 200-250, 250-300, 300-350, or 350-392 of SEQ ID NO:2), and at least one amino acid residue from amino acid residues 1 to 57 of SEQ ID NO:2.

47508 probes and primers are provided. Typically a probe/primer is an isolated or purified oligonucleotide. The oligonucleotide typically includes a region of nucleotide

sequence that hybridizes under a stringency condition described herein to at least about 7, 12 or 15, preferably about 20 or 25, more preferably about 30, 35, 40, 45, 50, 55, 60, 65, or 75 consecutive nucleotides of a sense or antisense sequence of SEQ ID NO:1 or SEQ ID NO:3, or of a naturally occurring allelic variant or mutant of SEQ ID NO:1 or SEQ ID NO:3.

5 In a preferred embodiment the nucleic acid is a probe which is at least 5 or 10, and less than 200, more preferably less than 100, or less than 50, base pairs in length. It should be identical, or differ by 1, or less than in 5 or 10 bases, from a sequence disclosed herein. If alignment is needed for this comparison the sequences should be aligned for maximum homology. "Looped" out sequences from deletions or insertions, or mismatches, are
10 considered differences.

A probe or primer can be derived from the sense or anti-sense strand of a nucleic acid which encodes: the 5' UTR of 47508, e.g., about nucleotides 1 to 65 of SEQ ID NO:1; N-terminal portions of human 47508, e.g., about amino acid residues 1 to 57 of SEQ ID NO:2; the histone deacetylase domain of human 47508, e.g., about amino acid residues 83 to 15 392; catalytically important motifs of the histone deacetylase domain of human 47508, e.g. about amino acid residues 205 to 215, or 240 to 255, or 325 to 335 of SEQ ID NO:2; or other fragments of the histone deacetylase domain of human 47508, e.g., about amino acid residues 260 to 270 of SEQ ID NO:2.

In another embodiment, a set of primers is provided, e.g., primers suitable for use in
20 a PCR, which can be used to amplify a selected region of a 47508 sequence, e.g., a domain, region, site or other sequence described herein. The primers should be at least 5, 10, or 50 base pairs in length and less than 100, or less than 200, base pairs in length. The primers should be identical, or differs by one base from a sequence disclosed herein or from a naturally occurring variant. For example, primers suitable for amplifying all or a portion of
25 any of the following regions are provided: a 5'UTR of human 47508, e.g., about nucleotides 1 to 65 of SEQ ID NO:1; a region which encodes an N-terminal portion of human 47508, e.g., about amino acids 1 to 57 of SEQ ID NO:2; a region which encodes a histone deacetylase domain and at least one amino acid from about amino acid residues 1 to 57 of SEQ ID NO:2, e.g., from about amino acid 57 to 392 of SEQ ID NO:2; a region which
30 encodes a catalytically important fragment of the histone deacetylase domain of human 47508, e.g., about amino acid residues 205 to 215, 240 to 255, or 325 to 335; a region which encodes other portions of the histone deacetylase domain of human 47508, e.g., about amino acid residues 260 to 270 of SEQ ID NO:2.

A nucleic acid fragment can encode an epitope bearing region of a polypeptide described herein.

A nucleic acid fragment encoding a "biologically active portion of a 47508 polypeptide" can be prepared by isolating a portion of the nucleotide sequence of SEQ ID NO:1 or 3, which encodes a polypeptide having a 47508 biological activity (e.g., the biological activities of the 47508 proteins are described herein), expressing the encoded portion of the 47508 protein (e.g., by recombinant expression *in vitro*) and assessing the activity of the encoded portion of the 47508 protein. For example, a nucleic acid fragment encoding a biologically active portion of 47508 includes a histone deacetylase domain; at least one amino acid from about amino acid residues 1 to 57 of SEQ ID NO:2, e.g., from about amino acid 57 to 392 of SEQ ID NO:2. A nucleic acid fragment encoding a biologically active portion of a 47508 polypeptide, may comprise a nucleotide sequence which is greater than 300, 350, 400, 450, 500, 550, 600, 650, or more nucleotides in length.

In preferred embodiments, a nucleic acid includes a nucleotide sequence which is about 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1550, or more nucleotides in length and hybridizes under a stringency condition described herein to a nucleic acid molecule of SEQ ID NO:1, or SEQ ID NO:3. In a preferred embodiment, a nucleic acid of human 47508 includes at least one contiguous nucleotide from the region of about nucleotides 1-65, 1-234, 65-234, 65-311, 234-500, 312-700, 312-1307, 600-850, 750-850, 750-1000, 852-862, 900-1182, 1000-1100, 1150-1307, 1183-1307, 1183-1579, 1308-1579.

47508 Nucleic Acid Variants

The invention further encompasses nucleic acid molecules that differ from the nucleotide sequence shown in SEQ ID NO:1 or SEQ ID NO:3. Such differences can be due to degeneracy of the genetic code (and result in a nucleic acid which encodes the same 47508 proteins as those encoded by the nucleotide sequence disclosed herein. In another embodiment, an isolated nucleic acid molecule of the invention has a nucleotide sequence encoding a protein having an amino acid sequence which differs, by at least 1, but less than 5, 10, 20, 50, or 100 amino acid residues that shown in SEQ ID NO:2. If alignment is needed for this comparison the sequences should be aligned for maximum homology. "Looped" out sequences from deletions or insertions, or mismatches, are considered differences.

Nucleic acids of the inventor can be chosen for having codons, which are preferred, or non-preferred, for a particular expression system. E.g., the nucleic acid can be one in which at least one codon, at preferably at least 10%, or 20% of the codons has been altered such that the sequence is optimized for expression in *E. coli*, yeast, human, insect, or CHO cells.

Nucleic acid variants can be naturally occurring, such as allelic variants (same locus), homologs (different locus), and orthologs (different organism) or can be non naturally occurring. Non-naturally occurring variants can be made by mutagenesis techniques, including those applied to polynucleotides, cells, or organisms. The variants can contain nucleotide substitutions, deletions, inversions and insertions. Variation can occur in either or both the coding and non-coding regions. The variations can produce both conservative and non-conservative amino acid substitutions (as compared in the encoded product).

In a preferred embodiment, the nucleic acid differs from that of SEQ ID NO: 1 or 3, e.g., as follows: by at least one but less than 10, 20, 30, or 40 nucleotides; at least one but less than 1%, 5%, 10% or 20% of the nucleotides in the subject nucleic acid. If necessary for this analysis the sequences should be aligned for maximum homology. "Looped" out sequences from deletions or insertions, or mismatches, are considered differences.

Orthologs, homologs, and allelic variants can be identified using methods known in the art. These variants comprise a nucleotide sequence encoding a polypeptide that is 50%, at least about 55%, typically at least about 70-75%, more typically at least about 80-85%, and most typically at least about 90%, 95%, 98%, 99%, or more identical to the nucleotide sequence shown in SEQ ID NO:2 or a fragment of this sequence. Such nucleic acid molecules can readily be identified as being able to hybridize under a stringency condition described herein, to the nucleotide sequence shown in SEQ ID NO 2 or a fragment of the sequence. Nucleic acid molecules corresponding to orthologs, homologs, and allelic variants of the 47508 cDNAs of the invention can further be isolated by mapping to the same chromosome or locus as the 47508 gene.

Preferred variants include those that are correlated with histone deacetylase activity, e.g., deacetylation of histones H2A, H2B, H3, or H4.

Allelic variants of 47508, e.g., human 47508, include both functional and non-functional proteins. Functional allelic variants are naturally occurring amino acid sequence variants of the 47508 protein within a population that maintain the ability to deacetylate histones, e.g., histones H2A, H2B, H3, or H4, or to interact with transcription factors, e.g.,

transcriptional repressors. Functional allelic variants will typically contain only conservative substitution of one or more amino acids of SEQ ID NO:2, or substitution, deletion or insertion of non-critical residues in non-critical regions of the protein. Non-functional allelic variants are naturally-occurring amino acid sequence variants of the 47508, 5 e.g., human 47508, protein within a population that do not have the ability to deacetylate histones, e.g., histones H2A, H2B, H3, or H4, or to interact with transcription factors, e.g., transcriptional repressors. Non-functional allelic variants will typically contain a non-conservative substitution, a deletion, or insertion, or premature truncation of the amino acid sequence of SEQ ID NO:2, or a substitution, insertion, or deletion in critical residues or 10 critical regions of the protein.

Moreover, nucleic acid molecules encoding other 47508 family members and, thus, which have a nucleotide sequence which differs from the 47508 sequences of SEQ ID NO:1 or SEQ ID NO:3 are intended to be within the scope of the invention.

Antisense Nucleic Acid Molecules, Ribozymes and Modified 47508 Nucleic Acid

15 Molecules

In another aspect, the invention features, an isolated nucleic acid molecule which is antisense to 47508. An "antisense" nucleic acid can include a nucleotide sequence which is complementary to a "sense" nucleic acid encoding a protein, e.g., complementary to the coding strand of a double-stranded cDNA molecule or complementary to an mRNA 20 sequence. The antisense nucleic acid can be complementary to an entire 47508 coding strand, or to only a portion thereof (e.g., the coding region of human 47508 corresponding to SEQ ID NO:3). In another embodiment, the antisense nucleic acid molecule is antisense to a "noncoding region" of the coding strand of a nucleotide sequence encoding 47508 (e.g., the 5' and 3' untranslated regions).

25 An antisense nucleic acid can be designed such that it is complementary to the entire coding region of 47508 mRNA, but more preferably is an oligonucleotide which is antisense to only a portion of the coding or noncoding region of 47508 mRNA. For example, the antisense oligonucleotide can be complementary to the region surrounding the translation start site of 47508 mRNA, e.g., between the -10 and +10 regions of the target gene 30 nucleotide sequence of interest. An antisense oligonucleotide can be, for example, about 7, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, or more nucleotides in length.

An antisense nucleic acid of the invention can be constructed using chemical synthesis and enzymatic ligation reactions using procedures known in the art. For example, an antisense nucleic acid (e.g., an antisense oligonucleotide) can be chemically synthesized using naturally occurring nucleotides or variously modified nucleotides designed to increase 5 the biological stability of the molecules or to increase the physical stability of the duplex formed between the antisense and sense nucleic acids, e.g., phosphorothioate derivatives and acridine substituted nucleotides can be used. The antisense nucleic acid also can be produced biologically using an expression vector into which a nucleic acid has been subcloned in an antisense orientation (i.e., RNA transcribed from the inserted nucleic acid 10 will be of an antisense orientation to a target nucleic acid of interest, described further in the following subsection).

The antisense nucleic acid molecules of the invention are typically administered to a subject (e.g., by direct injection at a tissue site), or generated *in situ* such that they hybridize with or bind to cellular mRNA and/or genomic DNA encoding a 47508 protein to thereby 15 inhibit expression of the protein, e.g., by inhibiting transcription and/or translation.

Alternatively, antisense nucleic acid molecules can be modified to target selected cells and then administered systemically. For systemic administration, antisense molecules can be modified such that they specifically bind to receptors or antigens expressed on a selected cell surface, e.g., by linking the antisense nucleic acid molecules to peptides or antibodies 20 which bind to cell surface receptors or antigens. The antisense nucleic acid molecules can also be delivered to cells using the vectors described herein. To achieve sufficient intracellular concentrations of the antisense molecules, vector constructs in which the antisense nucleic acid molecule is placed under the control of a strong pol II or pol III promoter are preferred.

25 In yet another embodiment, the antisense nucleic acid molecule of the invention is an α -anomeric nucleic acid molecule. An α -anomeric nucleic acid molecule forms specific double-stranded hybrids with complementary RNA in which, contrary to the usual β -units, the strands run parallel to each other (Gaultier *et al.* (1987) *Nucleic Acids. Res.* 15:6625-6641). The antisense nucleic acid molecule can also comprise a 2'-o-methylribonucleotide 30 (Inoue *et al.* (1987) *Nucleic Acids Res.* 15:6131-6148) or a chimeric RNA-DNA analogue (Inoue *et al.* (1987) *FEBS Lett.* 215:327-330).

In still another embodiment, an antisense nucleic acid of the invention is a ribozyme. A ribozyme having specificity for a 47508-encoding nucleic acid can include one or more

sequences complementary to the nucleotide sequence of a 47508 cDNA disclosed herein (i.e., SEQ ID NO:1 or SEQ ID NO:3), and a sequence having known catalytic sequence responsible for mRNA cleavage (see U.S. Pat. No. 5,093,246 or Haselhoff and Gerlach (1988) *Nature* 334:585-591). For example, a derivative of a *Tetrahymena* L-19 IVS RNA 5 can be constructed in which the nucleotide sequence of the active site is complementary to the nucleotide sequence to be cleaved in a 47508-encoding mRNA. See, e.g., Cech *et al.* U.S. Patent No. 4,987,071; and Cech *et al.* U.S. Patent No. 5,116,742. Alternatively, 47508 mRNA can be used to select a catalytic RNA having a specific ribonuclease activity from a pool of RNA molecules. See, e.g., Bartel, D. and Szostak, J.W. (1993) *Science* 261:1411-10 1418.

47508 gene expression can be inhibited by targeting nucleotide sequences complementary to the regulatory region of the 47508 (e.g., the 47508 promoter and/or enhancers) to form triple helical structures that prevent transcription of the 47508 gene in target cells. See generally, Helene, C. (1991) *Anticancer Drug Des.* 6:569-84; Helene, C. i 15 (1992) *Ann. N.Y. Acad. Sci.* 660:27-36; and Maher, L.J. (1992) *Bioassays* 14:807-15. The potential sequences that can be targeted for triple helix formation can be increased by creating a so-called "switchback" nucleic acid molecule. Switchback molecules are synthesized in an alternating 5'-3', 3'-5' manner, such that they base pair with first one strand of a duplex and then the other, eliminating the necessity for a sizeable stretch of either 20 purines or pyrimidines to be present on one strand of a duplex.

The invention also provides detectably labeled oligonucleotide primer and probe molecules. Typically, such labels are chemiluminescent, fluorescent, radioactive, or colorimetric.

A 47508 nucleic acid molecule can be modified at the base moiety, sugar moiety or 25 phosphate backbone to improve, e.g., the stability, hybridization, or solubility of the molecule. For non-limiting examples of synthetic oligonucleotides with modifications see Toulmé (2001) *Nature Biotech.* 19:17 and Faria *et al.* (2001) *Nature Biotech.* 19:40-44. Such phosphoramidite oligonucleotides can be effective antisense agents.

For example, the deoxyribose phosphate backbone of the nucleic acid molecules can 30 be modified to generate peptide nucleic acids (see Hyrup B. *et al.* (1996) *Bioorganic & Medicinal Chemistry* 4: 5-23). As used herein, the terms "peptide nucleic acid" or "PNA" refers to a nucleic acid mimic, e.g., a DNA mimic, in which the deoxyribose phosphate backbone is replaced by a pseudopeptide backbone and only the four natural nucleobases are

retained. The neutral backbone of a PNA can allow for specific hybridization to DNA and RNA under conditions of low ionic strength. The synthesis of PNA oligomers can be performed using standard solid phase peptide synthesis protocols as described in Hyrup B. *et al.* (1996) *supra* and Perry-O'Keefe *et al.* *Proc. Natl. Acad. Sci.* 93: 14670-675.

5 PNAs of 47508 nucleic acid molecules can be used in therapeutic and diagnostic applications. For example, PNAs can be used as antisense or antigene agents for sequence-specific modulation of gene expression by, for example, inducing transcription or translation arrest or inhibiting replication. PNAs of 47508 nucleic acid molecules can also be used in the analysis of single base pair mutations in a gene, (e.g., by PNA-directed PCR clamping);
10 as 'artificial restriction enzymes' when used in combination with other enzymes, (e.g., S1 nucleases (Hyrup B. *et al.* (1996) *supra*)); or as probes or primers for DNA sequencing or hybridization (Hyrup B. *et al.* (1996) *supra*; Perry-O'Keefe *supra*).

15 In other embodiments, the oligonucleotide may include other appended groups such as peptides (e.g., for targeting host cell receptors *in vivo*), or agents facilitating transport across the cell membrane (see, e.g., Letsinger *et al.* (1989) *Proc. Natl. Acad. Sci. USA* 86:6553-6556; Lemaitre *et al.* (1987) *Proc. Natl. Acad. Sci. USA* 84:648-652; PCT Publication No. W088/09810) or the blood-brain barrier (see, e.g., PCT Publication No. W089/10134). In addition, oligonucleotides can be modified with hybridization-triggered cleavage agents (see, e.g., Krol *et al.* (1988) *Bio-Techniques* 6:958-976) or intercalating
20 agents. (see, e.g., Zon (1988) *Pharm. Res.* 5:539-549). To this end, the oligonucleotide may be conjugated to another molecule, (e.g., a peptide, hybridization triggered cross-linking agent, transport agent, or hybridization-triggered cleavage agent).

25 The invention also includes molecular beacon oligonucleotide primer and probe molecules having at least one region which is complementary to a 47508 nucleic acid of the invention, two complementary regions one having a fluorophore and one a quencher such that the molecular beacon is useful for quantitating the presence of the 47508 nucleic acid of the invention in a sample. Molecular beacon nucleic acids are described, for example, in Lizardi *et al.*, U.S. Patent No. 5,854,033; Nazarenko *et al.*, U.S. Patent No. 5,866,336, and Livak *et al.*, U.S. Patent 5,876,930.

30 Isolated 47508 Polypeptides

In another aspect, the invention features, an isolated 47508 protein, or fragment, e.g., a biologically active portion, for use as immunogens or antigens to raise or test (or more

generally to bind) anti-47508 antibodies. 47508 protein can be isolated from cells or tissue sources using standard protein purification techniques. 47508 protein or fragments thereof can be produced by recombinant DNA techniques or synthesized chemically.

Polypeptides of the invention include those which arise as a result of the existence of 5 multiple genes, alternative transcription events, alternative RNA splicing events, and alternative translational and post-translational events. The polypeptide can be expressed in systems, e.g., cultured cells, which result in substantially the same post-translational modifications present when expressed the polypeptide is expressed in a native cell, or in systems which result in the alteration or omission of post-translational modifications, e.g., 10 glycosylation or cleavage, present when expressed in a native cell.

In a preferred embodiment, a 47508 polypeptide has one or more of the following characteristics:

- (i) it has the ability to deacetylate histones, e.g., histones H2A, H2B, H3, or H4;
- (ii) it has a molecular weight, e.g., a deduced molecular weight, preferably ignoring 15 any contribution of post translational modifications, amino acid composition or other physical characteristic of a 47508 polypeptide, e.g., a polypeptide of SEQ ID NO:2;
- (iii) it has an overall sequence similarity of at least 60%, more preferably at least 70%, 80%, 90%, 95%, 98%, 99%, or more with a polypeptide a of SEQ ID NO:2;
- (iv) it can be found in the nucleus of a cell;
- 20 (v) it has a histone deacetylase domain which is preferably about 70%, 80%, 90%, 95%, 98%, 99%, or more homologous to amino acid residues about 83 to 392 of SEQ ID NO:2;
- (vi) it has at least one histone deacetylase zinc-binding triad;
- (vii) it has at least two charge-relay systems;
- 25 (viii) it can colocalize with transcription factors, e.g., transcriptional repressors;
- (ix) it has at least one, two, three, preferably four predicted Protein kinase C phosphorylation sites (PS00005);
- (x) it has at least one, two, three, four, preferably five predicted Casein kinase II phosphorylation sites (PS00006);
- 30 (xi) it has at least one, two, three, four, five, six, preferably seven predicted N-myristoylation sites (PS00008); or
- (xii) it has at least one predicted amidation site (PS00009).

In a preferred embodiment the 47508 protein, or fragment thereof, differs from the corresponding sequence in SEQ ID:2. In one embodiment it differs by at least one but by less than 15, 10 or 5 amino acid residues. In another it differs from the corresponding sequence in SEQ ID NO:2 by at least one residue but less than 20%, 15%, 10% or 5% of the residues in it differ from the corresponding sequence in SEQ ID NO:2. (If this comparison requires alignment the sequences should be aligned for maximum homology. "Looped" out sequences from deletions or insertions, or mismatches, are considered differences.) The differences are, preferably, differences or changes at a non essential residue or a conservative substitution. In a preferred embodiment the differences are not in the histone deacetylase domain, e.g., about amino acid residues 83 to 392 of SEQ ID NO:2. In another preferred embodiment one or more differences are in the histone deacetylase domain, e.g., about amino acids 83 to 392 of SEQ ID NO:2.

Other embodiments include a protein that contain one or more changes in amino acid sequence, e.g., a change in an amino acid residue which is not essential for activity. Such 47508 proteins differ in amino acid sequence from SEQ ID NO:2, yet retain biological activity.

In one embodiment, the protein includes an amino acid sequence at least about 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 98%, 99% or more homologous to SEQ ID NO:2.

A 47508 protein or fragment is provided which varies from the sequence of SEQ ID NO:2 in regions defined by amino acids about 83 to 392 by at least one but by less than 15, 10 or 5 amino acid residues in the protein or fragment but which does not differ from SEQ ID NO:2 in regions defined by amino acids about 263 to 266. (If this comparison requires alignment the sequences should be aligned for maximum homology. "Looped" out sequences from deletions or insertions, or mismatches, are considered differences.) In some embodiments the difference is at a non-essential residue or is a conservative substitution, while in others the difference is at an essential residue or is a non-conservative substitution.

In one embodiment, a biologically active portion of a 47508 protein includes a histone deacetylase domain. Moreover, other biologically active portions, in which other regions of the protein are deleted, can be prepared by recombinant techniques and evaluated for one or more of the functional activities of a native 47508 protein.

In a preferred embodiment, the 47508 protein has an amino acid sequence shown in SEQ ID NO:2. In other embodiments, the 47508 protein is substantially identical to SEQ ID NO:2. In another embodiment, the 47508 protein is substantially identical to SEQ ID NO:2

and retains the functional activity of the protein of SEQ ID NO:2, as described in detail in the subsections above. In yet another embodiment, the 47508 protein or fragment thereof includes at least one amino acid from amino acid residues 1 to 57, or 263 to 266 of SEQ ID NO:2.

5 47508 Chimeric or Fusion Proteins

In another aspect, the invention provides 47508 chimeric or fusion proteins. As used herein, a 47508 "chimeric protein" or "fusion protein" includes a 47508 polypeptide linked to a non-47508 polypeptide. A "non-47508 polypeptide" refers to a polypeptide having an amino acid sequence corresponding to a protein which is not substantially homologous to 10 the 47508 protein, e.g., a protein which is different from the 47508 protein and which is derived from the same or a different organism. The 47508 polypeptide of the fusion protein can correspond to all or a portion e.g., a fragment described herein of a 47508 amino acid sequence. In a preferred embodiment, a 47508 fusion protein includes at least one (or two) 15 biologically active portion of a 47508 protein. The non-47508 polypeptide can be fused to the N-terminus or C-terminus of the 47508 polypeptide.

The fusion protein can include a moiety which has a high affinity for a ligand. For example, the fusion protein can be a GST-47508 fusion protein in which the 47508 sequences are fused to the C-terminus of the GST sequences. Such fusion proteins can facilitate the purification of recombinant 47508. Alternatively, the fusion protein can be a 20 47508 protein containing a heterologous signal sequence at its N-terminus. In certain host cells (e.g., mammalian host cells), expression and/or secretion of 47508 can be increased through use of a heterologous signal sequence.

Fusion proteins can include all or a part of a serum protein, e.g., an IgG constant region, or human serum albumin.

25 The 47508 fusion proteins of the invention can be incorporated into pharmaceutical compositions and administered to a subject *in vivo*. The 47508 fusion proteins can be used to affect the bioavailability of a 47508 substrate. 47508 fusion proteins may be useful therapeutically for the treatment of disorders caused by, for example, (i) aberrant modification or mutation of a gene encoding a 47508 protein; (ii) mis-regulation of the 30 47508 gene; and (iii) aberrant post-translational modification of a 47508 protein.

Moreover, the 47508-fusion proteins of the invention can be used as immunogens to produce anti-47508 antibodies in a subject, to purify 47508 ligands and in screening assays to identify molecules which inhibit the interaction of 47508 with a 47508 substrate.

5 Expression vectors are commercially available that already encode a fusion moiety (e.g., a GST polypeptide). A 47508-encoding nucleic acid can be cloned into such an expression vector such that the fusion moiety is linked in-frame to the 47508 protein.

Variants of 47508 Proteins

In another aspect, the invention also features a variant of a 47508 polypeptide, e.g., which functions as an agonist (mimetics) or as an antagonist. Variants of the 47508 proteins 10 can be generated by mutagenesis, e.g., discrete point mutation, the insertion or deletion of sequences or the truncation of a 47508 protein. An agonist of the 47508 proteins can retain substantially the same, or a subset, of the biological activities of the naturally occurring form of a 47508 protein. An antagonist of a 47508 protein can inhibit one or more of the 15 activities of the naturally occurring form of the 47508 protein by, for example, competitively modulating a 47508-mediated activity of a 47508 protein. Thus, specific biological effects can be elicited by treatment with a variant of limited function. Preferably, treatment of a subject with a variant having a subset of the biological activities of the naturally occurring form of the protein has fewer side effects in a subject relative to treatment with the naturally occurring form of the 47508 protein.

20 Variants of a 47508 protein can be identified by screening combinatorial libraries of mutants, e.g., truncation mutants, of a 47508 protein for agonist or antagonist activity.

Libraries of fragments e.g., N terminal, C terminal, or internal fragments, of a 47508 25 protein coding sequence can be used to generate a variegated population of fragments for screening and subsequent selection of variants of a 47508 protein. Variants in which a cysteine residues is added or deleted or in which a residue which is glycosylated is added or deleted are particularly preferred.

Methods for screening gene products of combinatorial libraries made by point 30 mutations or truncation, and for screening cDNA libraries for gene products having a selected property are known in the art. Such methods are adaptable for rapid screening of the gene libraries generated by combinatorial mutagenesis of 47508 proteins. Recursive ensemble mutagenesis (REM), a new technique which enhances the frequency of functional mutants in the libraries, can be used in combination with the screening assays to identify

47508 variants (Arkin and Yourvan (1992) *Proc. Natl. Acad. Sci. USA* 89:7811-7815; Delgrave *et al.* (1993) *Protein Engineering* 6:327-331).

Cell based assays can be exploited to analyze a variegated 47508 library. For example, a library of expression vectors can be transfected into a cell line, e.g., a cell line, 5 which ordinarily responds to 47508 in a substrate-dependent manner. The transfected cells are then contacted with 47508 and the effect of the expression of the mutant on signaling by the 47508 substrate can be detected, e.g., by measuring histone deacetylase activity. Plasmid DNA can then be recovered from the cells which score for inhibition, or alternatively, potentiation of signaling by the 47508 substrate, and the individual clones 10 further characterized.

In another aspect, the invention features a method of making a 47508 polypeptide, e.g., a peptide having a non-wild type activity, e.g., an antagonist, agonist, or super agonist of a naturally occurring 47508 polypeptide, e.g., a naturally occurring 47508 polypeptide. The method includes: altering the sequence of a 47508 polypeptide, e.g., altering the 15 sequence, e.g., by substitution or deletion of one or more residues of a non-conserved region, a domain or residue disclosed herein, and testing the altered polypeptide for the desired activity.

In another aspect, the invention features a method of making a fragment or analog of a 47508 polypeptide a biological activity of a naturally occurring 47508 polypeptide. The 20 method includes: altering the sequence, e.g., by substitution or deletion of one or more residues, of a 47508 polypeptide, e.g., altering the sequence of a non-conserved region, or a domain or residue described herein, and testing the altered polypeptide for the desired activity.

Anti-47508 Antibodies

25 In another aspect, the invention provides an anti-47508 antibody, or a fragment thereof (e.g., an antigen-binding fragment thereof). The term "antibody" as used herein refers to an immunoglobulin molecule or immunologically active portion thereof, i.e., an antigen-binding portion. As used herein, the term "antibody" refers to a protein comprising at least one, and preferably two, heavy (H) chain variable regions (abbreviated herein as 30 VH), and at least one and preferably two light (L) chain variable regions (abbreviated herein as VL). The VH and VL regions can be further subdivided into regions of hypervariability, termed "complementarity determining regions" ("CDR"), interspersed with regions that are

more conserved, termed "framework regions" (FR). The extent of the framework region and CDR's has been precisely defined (see, Kabat, E.A., *et al.* (1991) *Sequences of Proteins of Immunological Interest, Fifth Edition*, U.S. Department of Health and Human Services, NIH Publication No. 91-3242, and Chothia, C. *et al.* (1987) *J. Mol. Biol.* 196:901-917, which are 5 incorporated herein by reference). Each VH and VL is composed of three CDR's and four FRs, arranged from amino-terminus to carboxy-terminus in the following order: FR1, CDR1, FR2, CDR2, FR3, CDR3, FR4.

The anti-47508 antibody can further include a heavy and light chain constant region, to thereby form a heavy and light immunoglobulin chain, respectively. In one embodiment, 10 the antibody is a tetramer of two heavy immunoglobulin chains and two light immunoglobulin chains, wherein the heavy and light immunoglobulin chains are interconnected by, e.g., disulfide bonds. The heavy chain constant region is comprised of three domains, CH1, CH2 and CH3. The light chain constant region is comprised of one domain, CL. The variable region of the heavy and light chains contains a binding domain that 15 interacts with an antigen. The constant regions of the antibodies typically mediate the binding of the antibody to host tissues or factors, including various cells of the immune system (e.g., effector cells) and the first component (Clq) of the classical complement system.

As used herein, the term "immunoglobulin" refers to a protein consisting of one or 20 more polypeptides substantially encoded by immunoglobulin genes. The recognized human immunoglobulin genes include the kappa, lambda, alpha (IgA1 and IgA2), gamma (IgG1, IgG2, IgG3, IgG4), delta, epsilon and mu constant region genes, as well as the myriad immunoglobulin variable region genes. Full-length immunoglobulin "light chains" (about 25 KDa or 214 amino acids) are encoded by a variable region gene at the NH₂-terminus 25 (about 110 amino acids) and a kappa or lambda constant region gene at the COOH-terminus. Full-length immunoglobulin "heavy chains" (about 50 KDa or 446 amino acids), are similarly encoded by a variable region gene (about 116 amino acids) and one of the other aforementioned constant region genes, e.g., gamma (encoding about 330 amino acids).

30 The term "antigen-binding fragment" of an antibody (or simply "antibody portion," or "fragment"), as used herein, refers to one or more fragments of a full-length antibody that retain the ability to specifically bind to the antigen, e.g., 47508 polypeptide or fragment thereof. Examples of antigen-binding fragments of the anti-47508 antibody include, but are

not limited to: (i) a Fab fragment, a monovalent fragment consisting of the VL, VH, CL and CH1 domains; (ii) a $F(ab')_2$ fragment, a bivalent fragment comprising two Fab fragments linked by a disulfide bridge at the hinge region; (iii) a Fd fragment consisting of the VH and CH1 domains; (iv) a Fv fragment consisting of the VL and VH domains of a single arm of an antibody, (v) a dAb fragment (Ward *et al.*, (1989) *Nature* 341:544-546), which consists of a VH domain; and (vi) an isolated complementarity determining region (CDR). Furthermore, although the two domains of the Fv fragment, VL and VH, are coded for by separate genes, they can be joined, using recombinant methods, by a synthetic linker that enables them to be made as a single protein chain in which the VL and VH regions pair to form monovalent molecules (known as single chain Fv (scFv); see e.g., Bird *et al.* (1988) *Science* 242:423-426; and Huston *et al.* (1988) *Proc. Natl. Acad. Sci. USA* 85:5879-5883). Such single chain antibodies are also encompassed within the term "antigen-binding fragment" of an antibody. These antibody fragments are obtained using conventional techniques known to those with skill in the art, and the fragments are screened for utility in the same manner as are intact antibodies.

The anti-47508 antibody can be a polyclonal or a monoclonal antibody. In other embodiments, the antibody can be recombinantly produced, e.g., produced by phage display or by combinatorial methods.

Phage display and combinatorial methods for generating anti-47508 antibodies are known in the art (as described in, e.g., Ladner *et al.* U.S. Patent No. 5,223,409; Kang *et al.* International Publication No. WO 92/18619; Dower *et al.* International Publication No. WO 91/17271; Winter *et al.* International Publication WO 92/20791; Markland *et al.* International Publication No. WO 92/15679; Breitling *et al.* International Publication WO 93/01288; McCafferty *et al.* International Publication No. WO 92/01047; Garrard *et al.* International Publication No. WO 92/09690; Ladner *et al.* International Publication No. WO 90/02809; Fuchs *et al.* (1991) *Bio/Technology* 9:1370-1372; Hay *et al.* (1992) *Hum Antibod Hybridomas* 3:81-85; Huse *et al.* (1989) *Science* 246:1275-1281; Griffiths *et al.* (1993) *EMBO J* 12:725-734; Hawkins *et al.* (1992) *J Mol Biol* 226:889-896; Clackson *et al.* (1991) *Nature* 352:624-628; Gram *et al.* (1992) *PNAS* 89:3576-3580; Garrad *et al.* (1991) *Bio/Technology* 9:1373-1377; Hoogenboom *et al.* (1991) *Nuc Acid Res* 19:4133-4137; and Barbas *et al.* (1991) *PNAS* 88:7978-7982, the contents of all of which are incorporated by reference herein).

In one embodiment, the anti-47508 antibody is a fully human antibody (e.g., an antibody made in a mouse which has been genetically engineered to produce an antibody from a human immunoglobulin sequence), or a non-human antibody, e.g., a rodent (mouse or rat), goat, primate (e.g., monkey), camel antibody. Preferably, the non-human antibody is 5 a rodent (mouse or rat antibody). Method of producing rodent antibodies are known in the art.

Human monoclonal antibodies can be generated using transgenic mice carrying the human immunoglobulin genes rather than the mouse system. Splenocytes from these transgenic mice immunized with the antigen of interest are used to produce hybridomas that 10 secrete human mAbs with specific affinities for epitopes from a human protein (see, e.g., Wood et al. International Application WO 91/00906, Kucherlapati et al. PCT publication WO 91/10741; Lonberg et al. International Application WO 92/03918; Kay et al. International Application 92/03917; Lonberg, N. et al. 1994 *Nature* 368:856-859; Green, L.L. et al. 1994 *Nature Genet.* 7:13-21; Morrison, S.L. et al. 1994 *Proc. Natl. Acad. Sci. USA* 81:6851-6855; Bruggeman et al. 1993 *Year Immunol* 7:33-40; Tuuillon et al. 1993 *PNAS* 90:3720-3724; Bruggeman et al. 1991 *Eur J Immunol* 21:1323-1326).

An anti-47508 antibody can be one in which the variable region, or a portion thereof, e.g., the CDR's, are generated in a non-human organism, e.g., a rat or mouse. Chimeric, 20 CDR-grafted, and humanized antibodies are within the invention. Antibodies generated in a non-human organism, e.g., a rat or mouse, and then modified, e.g., in the variable framework or constant region, to decrease antigenicity in a human are within the invention.

Chimeric antibodies can be produced by recombinant DNA techniques known in the art. For example, a gene encoding the Fc constant region of a murine (or other species) 25 monoclonal antibody molecule is digested with restriction enzymes to remove the region encoding the murine Fc, and the equivalent portion of a gene encoding a human Fc constant region is substituted (see Robinson et al., International Patent Publication PCT/US86/02269; Akira, et al., European Patent Application 184,187; Taniguchi, M., European Patent Application 171,496; Morrison et al., European Patent Application 173,494; Neuberger et al., International Application WO 86/01533; Cabilly et al. U.S. Patent No. 4,816,567; 30 Cabilly et al., European Patent Application 125,023; Better et al. (1988 *Science* 240:1041-1043); Liu et al. (1987) *PNAS* 84:3439-3443; Liu et al., 1987, *J. Immunol.* 139:3521-3526; Sun et al. (1987) *PNAS* 84:214-218; Nishimura et al., 1987, *Canc. Res.* 47:999-1005; Wood et al. (1985) *Nature* 314:446-449; and Shaw et al., 1988, *J. Natl Cancer Inst.* 80:1553-1559).

A humanized or CDR-grafted antibody will have at least one or two but generally all three recipient CDR's (of heavy and or light immuoglobulin chains) replaced with a donor CDR. The antibody may be replaced with at least a portion of a non-human CDR or only some of the CDR's may be replaced with non-human CDR's. It is only necessary to replace 5 the number of CDR's required for binding of the humanized antibody to a 47508 or a fragment thereof. Preferably, the donor will be a rodent antibody, e.g., a rat or mouse antibody, and the recipient will be a human framework or a human consensus framework. Typically, the immunoglobulin providing the CDR's is called the "donor" and the immunoglobulin providing the framework is called the "acceptor." In one embodiment, the 10 donor immunoglobulin is a non-human (e.g., rodent). The acceptor framework is a naturally-occurring (e.g., a human) framework or a consensus framework, or a sequence about 85% or higher, preferably 90%, 95%, 99% or higher identical thereto.

As used herein, the term "consensus sequence" refers to the sequence formed from the most frequently occurring amino acids (or nucleotides) in a family of related sequences (See 15 e.g., Winnaker, From Genes to Clones (Verlagsgesellschaft, Weinheim, Germany 1987). In a family of proteins, each position in the consensus sequence is occupied by the amino acid occurring most frequently at that position in the family. If two amino acids occur equally frequently, either can be included in the consensus sequence. A "consensus framework" refers to the framework region in the consensus immunoglobulin sequence.

20 An antibody can be humanized by methods known in the art. Humanized antibodies can be generated by replacing sequences of the Fv variable region which are not directly involved in antigen binding with equivalent sequences from human Fv variable regions. General methods for generating humanized antibodies are provided by Morrison, S. L., 1985, *Science* 229:1202-1207, by Oi et al., 1986, *BioTechniques* 4:214, and by Queen et al. 25 US 5,585,089, US 5,693,761 and US 5,693,762, the contents of all of which are hereby incorporated by reference. Those methods include isolating, manipulating, and expressing the nucleic acid sequences that encode all or part of immunoglobulin Fv variable regions from at least one of a heavy or light chain. Sources of such nucleic acid are well known to those skilled in the art and, for example, may be obtained from a hybridoma producing an 30 antibody against a 47508 polypeptide or fragment thereof. The recombinant DNA encoding the humanized antibody, or fragment thereof, can then be cloned into an appropriate expression vector.

Humanized or CDR-grafted antibodies can be produced by CDR-grafting or CDR substitution, wherein one, two, or all CDR's of an immunoglobulin chain can be replaced. See e.g., U.S. Patent 5,225,539; Jones et al. 1986 *Nature* 321:552-525; Verhoeyan et al. 1988 *Science* 239:1534; Beidler et al. 1988 *J. Immunol.* 141:4053-4060; Winter US 5,225,539, the contents of all of which are hereby expressly incorporated by reference. Winter describes a CDR-grafting method which may be used to prepare the humanized antibodies of the present invention (UK Patent Application GB 2188638A, filed on March 26, 1987; Winter US 5,225,539), the contents of which is expressly incorporated by reference.

10 Also within the scope of the invention are humanized antibodies in which specific amino acids have been substituted, deleted or added. Preferred humanized antibodies have amino acid substitutions in the framework region, such as to improve binding to the antigen. For example, a humanized antibody will have framework residues identical to the donor framework residue or to another amino acid other than the recipient framework residue. To 15 generate such antibodies, a selected, small number of acceptor framework residues of the humanized immunoglobulin chain can be replaced by the corresponding donor amino acids. Preferred locations of the substitutions include amino acid residues adjacent to the CDR, or which are capable of interacting with a CDR (see e.g., US 5,585,089). Criteria for selecting amino acids from the donor are described in US 5,585,089, e.g., columns 12-16 of US 20 5,585,089, the e.g., columns 12-16 of US 5,585,089, the contents of which are hereby incorporated by reference. Other techniques for humanizing antibodies are described in Padlan et al. EP 519596 A1, published on December 23, 1992.

25 In preferred embodiments an antibody can be made by immunizing with purified 47508 antigen, or a fragment thereof, e.g., a fragment described herein, membrane associated antigen, tissue, e.g., crude tissue preparations, whole cells, preferably living cells, lysed cells, or cell fractions, e.g., nuclear cytosol.

30 A full-length 47508 protein or, antigenic peptide fragment of 47508 can be used as an immunogen or can be used to identify anti-47508 antibodies made with other immunogens, e.g., cells, membrane preparations, and the like. The antigenic peptide of 47508 should include at least 8 amino acid residues of the amino acid sequence shown in SEQ ID NO:2 and encompasses an epitope of 47508. Preferably, the antigenic peptide includes at least 10 amino acid residues, more preferably at least 15 amino acid residues,

even more preferably at least 20 amino acid residues, and most preferably at least 30 amino acid residues.

Fragments of 47508 can be used as immunogens or used to characterize the specificity of an antibody. For example, fragments of 47508 which include residues about 5 19 to 35, about 245 to 263, or about 286 to 310 can be used to make, e.g., antibodies against hydrophilic regions of the 47508 protein. Similarly, fragments of 47508 which include residues about 151 to 172, about 215 to 232, or about 377 to 393 can be used to make an antibody against a hydrophobic region of the 47508 protein; fragments of 47508 which include residues about 1 to 57, or about 50 to 82 can be used to make an antibody against an 10 N-terminal portion of the 47508 protein; and fragments of 47508 which include residues about 90 to 110, about 200 to 220, about 240 to 260, about 320 to 340, or about 360 to 375 can be used to make an antibody against the histone deacetylase region of the 47508 protein.

Antibodies reactive with, or specific for, any of these regions, or other regions or domains described herein are provided.

15 Antibodies which bind only native 47508 protein, only denatured or otherwise non-native 47508 protein, or which bind both, are within the invention. Antibodies with linear or conformational epitopes are within the invention. Conformational epitopes can sometimes be identified by identifying antibodies which bind to native but not denatured 47508 protein.

20 Preferred epitopes encompassed by the antigenic peptide are regions of 47508 are located on the surface of the protein, e.g., hydrophilic regions, as well as regions with high antigenicity. For example, an Emini surface probability analysis of the human 47508 protein sequence can be used to indicate the regions that have a particularly high probability of being localized to the surface of the 47508 protein and are thus likely to constitute surface 25 residues useful for targeting antibody production.

In preferred embodiments antibodies can bind one or more of purified antigen, membrane associated antigen, tissue, e.g., tissue sections, whole cells, preferably living cells, lysed cells, cell fractions, e.g., nuclear cytoplasm.

30 The anti-47508 antibody can be a single chain antibody. A single-chain antibody (scFV) may be engineered (see, for example, Colcher, D. *et al.* (1999) *Ann N Y Acad Sci* 880:263-80; and Reiter, Y. (1996) *Clin Cancer Res* 2:245-52). The single chain antibody can be dimerized or multimerized to generate multivalent antibodies having specificities for different epitopes of the same target 47508 protein.

In a preferred embodiment the antibody has: effector function; and can fix complement. In other embodiments the antibody does not; recruit effector cells; or fix complement.

5 In a preferred embodiment, the antibody has reduced or no ability to bind an Fc receptor. For example., it is a isotype or subtype, fragment or other mutant, which does not support binding to an Fc receptor, e.g., it has a mutagenized or deleted Fc receptor binding region.

10 In a preferred embodiment, an anti-47508 antibody alters (e.g., increases or decreases) the histone deacetylase activity of a 47508 polypeptide. For example, the antibody can bind at or in proximity to the active site, e.g., to an epitope that includes a residue located from about 90 to 110, about 200 to 220, about 240 to 260, about 320 to 340, or about 360 to 375 of SEQ ID NO:2.

15 The antibody can be coupled to a toxin, e.g., a polypeptide toxin, e.g, ricin or diphtheria toxin or active fragment hereof, or a radioactive nucleus, or imaging agent, e.g. a radioactive, enzymatic, or other, e.g., imaging agent, e.g., a NMR contrast agent. Labels which produce detectable radioactive emissions or fluorescence are preferred.

20 An anti-47508 antibody (e.g., monoclonal antibody) can be used to isolate 47508 by standard techniques, such as affinity chromatography or immunoprecipitation. Moreover, an anti-47508 antibody can be used to detect 47508 protein (e.g., in a cellular lysate or cell supernatant) in order to evaluate the abundance and pattern of expression of the protein. Anti-47508 antibodies can be used diagnostically to monitor protein levels in tissue as part of a clinical testing procedure, e.g., to determine the efficacy of a given treatment regimen. Detection can be facilitated by coupling (i.e., physically linking) the antibody to a detectable substance (i.e., antibody labelling). Examples of detectable substances include various 25 enzymes, prosthetic groups, fluorescent materials, luminescent materials, bioluminescent materials, and radioactive materials. Examples of suitable enzymes include horseradish peroxidase, alkaline phosphatase, β -galactosidase, or acetylcholinesterase; examples of suitable prosthetic group complexes include streptavidin/biotin and avidin/biotin; examples of suitable fluorescent materials include umbelliferone, fluorescein, fluorescein 30 isothiocyanate, rhodamine, dichlorotriazinylamine fluorescein, dansyl chloride or phycoerythrin; an example of a luminescent material includes luminol; examples of bioluminescent materials include luciferase, luciferin, and aequorin, and examples of suitable radioactive material include ^{125}I , ^{131}I , ^{35}S or ^3H .

The invention also includes a nucleic acids which encodes an anti-47508 antibody, e.g., an anti-47508 antibody described herein. Also included are vectors which include the nucleic acid and cells transformed with the nucleic acid, particularly cells which are useful for producing an antibody, e.g., mammalian cells, e.g. CHO or lymphatic cells.

5 The invention also includes cell lines, e.g., hybridomas, which make an anti-47508 antibody, e.g., and antibody described herein, and method of using said cells to make a 47508 antibody.

Recombinant Expression Vectors, Host Cells and Genetically Engineered Cells

In another aspect, the invention includes, vectors, preferably expression vectors, 10 containing a nucleic acid encoding a polypeptide described herein. As used herein, the term "vector" refers to a nucleic acid molecule capable of transporting another nucleic acid to which it has been linked and can include a plasmid, cosmid or viral vector. The vector can be capable of autonomous replication or it can integrate into a host DNA. Viral vectors include, e.g., replication defective retroviruses, adenoviruses and adeno-associated viruses.

15 A vector can include a 47508 nucleic acid in a form suitable for expression of the nucleic acid in a host cell. Preferably the recombinant expression vector includes one or more regulatory sequences operatively linked to the nucleic acid sequence to be expressed. The term "regulatory sequence" includes promoters, enhancers and other expression control elements (e.g., polyadenylation signals). Regulatory sequences include those which direct 20 constitutive expression of a nucleotide sequence, as well as tissue-specific regulatory and/or inducible sequences. The design of the expression vector can depend on such factors as the choice of the host cell to be transformed, the level of expression of protein desired, and the like. The expression vectors of the invention can be introduced into host cells to thereby produce proteins or polypeptides, including fusion proteins or polypeptides, encoded by 25 nucleic acids as described herein (e.g., 47508 proteins, mutant forms of 47508 proteins, fusion proteins, and the like).

The recombinant expression vectors of the invention can be designed for expression of 47508 proteins in prokaryotic or eukaryotic cells. For example, polypeptides of the invention can be expressed in *E. coli*, insect cells (e.g., using baculovirus expression 30 vectors), yeast cells or mammalian cells. Suitable host cells are discussed further in Goeddel, (1990) *Gene Expression Technology: Methods in Enzymology* 185, Academic Press, San Diego, CA. Alternatively, the recombinant expression vector can be transcribed

and translated *in vitro*, for example using T7 promoter regulatory sequences and T7 polymerase.

Expression of proteins in prokaryotes is most often carried out in *E. coli* with vectors containing constitutive or inducible promoters directing the expression of either fusion or 5 non-fusion proteins. Fusion vectors add a number of amino acids to a protein encoded therein, usually to the amino terminus of the recombinant protein. Such fusion vectors typically serve three purposes: 1) to increase expression of recombinant protein; 2) to increase the solubility of the recombinant protein; and 3) to aid in the purification of the recombinant protein by acting as a ligand in affinity purification. Often, a proteolytic 10 cleavage site is introduced at the junction of the fusion moiety and the recombinant protein to enable separation of the recombinant protein from the fusion moiety subsequent to purification of the fusion protein. Such enzymes, and their cognate recognition sequences, include Factor Xa, thrombin and enterokinase. Typical fusion expression vectors include pGEX (Pharmacia Biotech Inc; Smith, D.B. and Johnson, K.S. (1988) *Gene* 67:31-40), 15 pMAL (New England Biolabs, Beverly, MA) and pRITS (Pharmacia, Piscataway, NJ) which fuse glutathione S-transferase (GST), maltose E binding protein, or protein A, respectively, to the target recombinant protein.

Purified fusion proteins can be used in 47508 activity assays, (e.g., direct assays or competitive assays described in detail below), or to generate antibodies specific for 47508 20 proteins. In a preferred embodiment, a fusion protein expressed in a retroviral expression vector of the present invention can be used to infect bone marrow cells which are subsequently transplanted into irradiated recipients. The pathology of the subject recipient is then examined after sufficient time has passed (e.g., six weeks).

To maximize recombinant protein expression in *E. coli* is to express the protein in a 25 host bacteria with an impaired capacity to proteolytically cleave the recombinant protein (Gottesman, S., (1990) *Gene Expression Technology: Methods in Enzymology* 185, Academic Press, San Diego, California 119-128). Another strategy is to alter the nucleic acid sequence of the nucleic acid to be inserted into an expression vector so that the individual codons for each amino acid are those preferentially utilized in *E. coli* (Wada *et* 30 *al.*, (1992) *Nucleic Acids Res.* 20:2111-2118). Such alteration of nucleic acid sequences of the invention can be carried out by standard DNA synthesis techniques.

The 47508 expression vector can be a yeast expression vector, a vector for expression in insect cells, e.g., a baculovirus expression vector or a vector suitable for expression in mammalian cells.

When used in mammalian cells, the expression vector's control functions can be 5 provided by viral regulatory elements. For example, commonly used promoters are derived from polyoma, Adenovirus 2, cytomegalovirus and Simian Virus 40.

In another embodiment, the promoter is an inducible promoter, e.g., a promoter 10 regulated by a steroid hormone, by a polypeptide hormone (e.g., by means of a signal transduction pathway), or by a heterologous polypeptide (e.g., the tetracycline-inducible systems, "Tet-On" and "Tet-Off"; see, e.g., Clontech Inc., CA, Gossen and Bujard (1992) *Proc. Natl. Acad. Sci. USA* 89:5547, and Paillard (1989) *Human Gene Therapy* 9:983).

In another embodiment, the recombinant mammalian expression vector is capable of 15 directing expression of the nucleic acid preferentially in a particular cell type (e.g., tissue-specific regulatory elements are used to express the nucleic acid). Non-limiting examples of suitable tissue-specific promoters include the albumin promoter (liver-specific; Pinkert *et al.* 20 (1987) *Genes Dev.* 1:268-277), lymphoid-specific promoters (Calame and Eaton (1988) *Adv. Immunol.* 43:235-275), in particular promoters of T cell receptors (Winoto and Baltimore (1989) *EMBO J.* 8:729-733) and immunoglobulins (Banerji *et al.* (1983) *Cell* 33:729-740; Queen and Baltimore (1983) *Cell* 33:741-748), neuron-specific promoters (e.g., the neurofilament promoter; Byrne and Ruddle (1989) *Proc. Natl. Acad. Sci. USA* 86:5473-5477), pancreas-specific promoters (Edlund *et al.* (1985) *Science* 230:912-916), and 25 mammary gland-specific promoters (e.g., milk whey promoter; U.S. Patent No. 4,873,316 and European Application Publication No. 264,166). Developmentally-regulated promoters are also encompassed, for example, the murine hox promoters (Kessel and Gruss (1990) *Science* 249:374-379) and the α -fetoprotein promoter (Campes and Tilghman (1989) *Genes Dev.* 3:537-546).

The invention further provides a recombinant expression vector comprising a DNA molecule of the invention cloned into the expression vector in an antisense orientation. 30 Regulatory sequences (e.g., viral promoters and/or enhancers) operatively linked to a nucleic acid cloned in the antisense orientation can be chosen which direct the constitutive, tissue specific or cell type specific expression of antisense RNA in a variety of cell types. The antisense expression vector can be in the form of a recombinant plasmid, phagemid or attenuated virus.

Another aspect the invention provides a host cell which includes a nucleic acid molecule described herein, e.g., a 47508 nucleic acid molecule within a recombinant expression vector or a 47508 nucleic acid molecule containing sequences which allow it to homologously recombine into a specific site of the host cell's genome. The terms "host cell" and "recombinant host cell" are used interchangeably herein. Such terms refer not only to the particular subject cell but to the progeny or potential progeny of such a cell. Because certain modifications may occur in succeeding generations due to either mutation or environmental influences, such progeny may not, in fact, be identical to the parent cell, but are still included within the scope of the term as used herein.

10 A host cell can be any prokaryotic or eukaryotic cell. For example, a 47508 protein can be expressed in bacterial cells (such as *E. coli*), insect cells, yeast or mammalian cells (such as Chinese hamster ovary cells (CHO) or COS cells (African green monkey kidney cells CV-1 origin SV40 cells; Gluzman (1981) *Cell*23:175-182)). Other suitable host cells are known to those skilled in the art.

15 Vector DNA can be introduced into host cells via conventional transformation or transfection techniques. As used herein, the terms "transformation" and "transfection" are intended to refer to a variety of art-recognized techniques for introducing foreign nucleic acid (e.g., DNA) into a host cell, including calcium phosphate or calcium chloride co-precipitation, DEAE-dextran-mediated transfection, lipofection, or electroporation.

20 A host cell of the invention can be used to produce (i.e., express) a 47508 protein. Accordingly, the invention further provides methods for producing a 47508 protein using the host cells of the invention. In one embodiment, the method includes culturing the host cell of the invention (into which a recombinant expression vector encoding a 47508 protein has been introduced) in a suitable medium such that a 47508 protein is produced. In another 25 embodiment, the method further includes isolating a 47508 protein from the medium or the host cell.

30 In another aspect, the invention features, a cell or purified preparation of cells which include a 47508 transgene, or which otherwise misexpress 47508. The cell preparation can consist of human or non-human cells, e.g., rodent cells, e.g., mouse or rat cells, rabbit cells, or pig cells. In preferred embodiments, the cell or cells include a 47508 transgene, e.g., a heterologous form of a 47508, e.g., a gene derived from humans (in the case of a non-human cell). The 47508 transgene can be misexpressed, e.g., overexpressed or underexpressed. In other preferred embodiments, the cell or cells include a gene that mis-expresses an

endogenous 47508, e.g., a gene the expression of which is disrupted, e.g., a knockout. Such cells can serve as a model for studying disorders that are related to mutated or mis-expressed 47508 alleles or for use in drug screening.

In another aspect, the invention features, a human cell, e.g., a hematopoietic or 5 hepatic stem cell, transformed with nucleic acid which encodes a subject 47508 polypeptide.

Also provided are cells, preferably human cells, e.g., human hematopoietic, hepatic, or fibroblast cells, in which an endogenous 47508 is under the control of a regulatory sequence that does not normally control the expression of the endogenous 47508 gene. The expression characteristics of an endogenous gene within a cell, e.g., a cell line or 10 microorganism, can be modified by inserting a heterologous DNA regulatory element into the genome of the cell such that the inserted regulatory element is operably linked to the endogenous 47508 gene. For example, an endogenous 47508 gene which is "transcriptionally silent," e.g., not normally expressed, or expressed only at very low levels, may be activated by inserting a regulatory element which is capable of promoting the 15 expression of a normally expressed gene product in that cell. Techniques such as targeted homologous recombinations, can be used to insert the heterologous DNA as described in, e.g., Chappel, US 5,272,071; WO 91/06667, published in May 16, 1991.

In a preferred embodiment, recombinant cells described herein can be used for replacement therapy in a subject. For example, a nucleic acid encoding a 47508 polypeptide 20 operably linked to an inducible promoter (e.g., a steroid hormone receptor-regulated promoter) is introduced into a human or nonhuman, e.g., mammalian, e.g., porcine recombinant cell. The cell is cultivated and encapsulated in a biocompatible material, such as poly-lysine alginate, and subsequently implanted into the subject. See, e.g., Lanza (1996) *Nat. Biotechnol.* 14:1107; Joki *et al.* (2001) *Nat. Biotechnol.* 19:35; and U.S. Patent No. 25 5,876,742. Production of 47508 polypeptide can be regulated in the subject by administering an agent (e.g., a steroid hormone) to the subject. In another preferred embodiment, the implanted recombinant cells express and secrete an antibody specific for a 47508 polypeptide. The antibody can be any antibody or any antibody derivative described herein.

30 Transgenic Animals

The invention provides non-human transgenic animals. Such animals are useful for studying the function and/or activity of a 47508 protein and for identifying and/or evaluating

modulators of 47508 activity. As used herein, a "transgenic animal" is a non-human animal, preferably a mammal, more preferably a rodent such as a rat or mouse, in which one or more of the cells of the animal includes a transgene. Other examples of transgenic animals include non-human primates, sheep, dogs, cows, goats, chickens, amphibians, and the like.

5 A transgene is exogenous DNA or a rearrangement, e.g., a deletion of endogenous chromosomal DNA, which preferably is integrated into or occurs in the genome of the cells of a transgenic animal. A transgene can direct the expression of an encoded gene product in one or more cell types or tissues of the transgenic animal, other transgenes, e.g., a knockout, reduce expression. Thus, a transgenic animal can be one in which an endogenous 47508 10 gene has been altered by, e.g., by homologous recombination between the endogenous gene and an exogenous DNA molecule introduced into a cell of the animal, e.g., an embryonic cell of the animal, prior to development of the animal.

Intronic sequences and polyadenylation signals can also be included in the transgene to increase the efficiency of expression of the transgene. A tissue-specific regulatory 15 sequence(s) can be operably linked to a transgene of the invention to direct expression of a 47508 protein to particular cells. A transgenic founder animal can be identified based upon the presence of a 47508 transgene in its genome and/or expression of 47508 mRNA in tissues or cells of the animals. A transgenic founder animal can then be used to breed additional animals carrying the transgene. Moreover, transgenic animals carrying a 20 transgene encoding a 47508 protein can further be bred to other transgenic animals carrying other transgenes.

47508 proteins or polypeptides can be expressed in transgenic animals or plants, e.g., a nucleic acid encoding the protein or polypeptide can be introduced into the genome of an animal. In preferred embodiments the nucleic acid is placed under the control of a tissue 25 specific promoter, e.g., a milk or egg specific promoter, and recovered from the milk or eggs produced by the animal. Suitable animals are mice, pigs, cows, goats, and sheep.

The invention also includes a population of cells from a transgenic animal, as discussed, e.g., below.

Uses

30 The nucleic acid molecules, proteins, protein homologues, and antibodies described herein can be used in one or more of the following methods: a) screening assays; b)

predictive medicine (e.g., diagnostic assays, prognostic assays, monitoring clinical trials, and pharmacogenetics); and c) methods of treatment (e.g., therapeutic and prophylactic).

The isolated nucleic acid molecules of the invention can be used, for example, to express a 47508 protein (e.g., via a recombinant expression vector in a host cell in gene therapy applications), to detect a 47508 mRNA (e.g., in a biological sample) or a genetic alteration in a 47508 gene, and to modulate 47508 activity, as described further below. The 47508 proteins can be used to treat disorders characterized by insufficient or excessive production of a 47508 substrate or production of 47508 inhibitors. In addition, the 47508 proteins can be used to screen for naturally occurring 47508 substrates, to screen for drugs or compounds which modulate 47508 activity, as well as to treat disorders characterized by insufficient or excessive production of 47508 protein or production of 47508 protein forms which have decreased, aberrant or unwanted activity compared to 47508 wild type protein (e.g., cellular proliferative and/or differentiative disorder). Moreover, the anti-47508 antibodies of the invention can be used to detect and isolate 47508 proteins, regulate the bioavailability of 47508 proteins, and modulate 47508 activity.

A method of evaluating a compound for the ability to interact with, e.g., bind, a subject 47508 polypeptide is provided. The method includes: contacting the compound with the subject 47508 polypeptide; and evaluating ability of the compound to interact with, e.g., to bind or form a complex with the subject 47508 polypeptide. This method can be performed in vitro, e.g., in a cell free system, or in vivo, e.g., in a two-hybrid interaction trap assay. This method can be used to identify naturally occurring molecules that interact with subject 47508 polypeptide. It can also be used to find natural or synthetic inhibitors of subject 47508 polypeptide. Screening methods are discussed in more detail below.

Screening Assays

The invention provides methods (also referred to herein as "screening assays") for identifying modulators, i.e., candidate or test compounds or agents (e.g., proteins, peptides, peptidomimetics, peptoids, small molecules or other drugs) which bind to 47508 proteins, have a stimulatory or inhibitory effect on, for example, 47508 expression or 47508 activity, or have a stimulatory or inhibitory effect on, for example, the expression or activity of a 47508 substrate. Compounds thus identified can be used to modulate the activity of target gene products (e.g., 47508 genes) in a therapeutic protocol, to elaborate the biological

function of the target gene product, or to identify compounds that disrupt normal target gene interactions.

In one embodiment, the invention provides assays for screening candidate or test compounds which are substrates of a 47508 protein or polypeptide or a biologically active portion thereof. In another embodiment, the invention provides assays for screening candidate or test compounds that bind to or modulate an activity of a 47508 protein or polypeptide or a biologically active portion thereof.

In one embodiment, an activity of a 47508 protein can be assayed by expression a 47508 nucleic acid in a cell, e.g., a mammalian cell, such that 47508 protein is produced, 10 purifying the 47508 protein, e.g., by means of an affinity tag, e.g., a HIS6 tag, mixing the purified 47508 protein with histone proteins, e.g., histones H2A, H2B, H3, and H4, which are acetylated with H3-labeled acetyl groups, and monitoring cleavage of the labeled acetyl groups from the histone proteins over time. An example of this method is shown is Hu *et al.* (2000), *J Biol Chem* 275(20):15254-64, the contents of which are incorporated herein by 15 reference.

The test compounds of the present invention can be obtained using any of the numerous approaches in combinatorial library methods known in the art, including: biological libraries; peptoid libraries (libraries of molecules having the functionalities of peptides, but with a novel, non-peptide backbone which are resistant to enzymatic 20 degradation but which nevertheless remain bioactive; see, e.g., Zuckermann, R.N. *et al.* (1994) *J. Med. Chem.* 37:2678-85); spatially addressable parallel solid phase or solution phase libraries; synthetic library methods requiring deconvolution; the 'one-bead one-compound' library method; and synthetic library methods using affinity chromatography 25 selection. The biological library and peptoid library approaches are limited to peptide libraries, while the other four approaches are applicable to peptide, non-peptide oligomer or small molecule libraries of compounds (Lam (1997) *Anticancer Drug Des.* 12:145).

Examples of methods for the synthesis of molecular libraries can be found in the art, for example in: DeWitt *et al.* (1993) *Proc. Natl. Acad. Sci. U.S.A.* 90:6909; Erb *et al.* (1994) *Proc. Natl. Acad. Sci. USA* 91:11422; Zuckermann *et al.* (1994). *J. Med. Chem.* 37:2678; 30 Cho *et al.* (1993) *Science* 261:1303; Carrell *et al.* (1994) *Angew. Chem. Int. Ed. Engl.* 33:2059; Carell *et al.* (1994) *Angew. Chem. Int. Ed. Engl.* 33:2061; and Gallop *et al.* (1994) *J. Med. Chem.* 37:1233.

Libraries of compounds may be presented in solution (e.g., Houghten (1992) *Biotechniques* 13:412-421), or on beads (Lam (1991) *Nature* 354:82-84), chips (Fodor (1993) *Nature* 364:555-556), bacteria (Ladner, U.S. Patent No. 5,223,409), spores (Ladner U.S. Patent No. 5,223,409), plasmids (Cull *et al.* (1992) *Proc Natl Acad Sci USA* 89:1865-1869) or on phage (Scott and Smith (1990) *Science* 249:386-390; Devlin (1990) *Science* 249:404-406; Cwirla *et al.* (1990) *Proc. Natl. Acad. Sci.* 87:6378-6382; Felici (1991) *J. Mol. Biol.* 222:301-310; Ladner *supra*).

In one embodiment, an assay is a cell-based assay in which a cell which expresses a 47508 protein or biologically active portion thereof is contacted with a test compound, and 10 the ability of the test compound to modulate 47508 activity is determined. Determining the ability of the test compound to modulate 47508 activity can be accomplished by monitoring, for example, histone deacetylation, e.g., deacetylation of histone H2A, H2B, H3, or H4. The cell, for example, can be of mammalian origin, e.g., human.

The ability of the test compound to modulate 47508 binding to a compound, e.g., a 15 47508 substrate, or to bind to 47508 can also be evaluated. This can be accomplished, for example, by coupling the compound, e.g., the substrate, with a radioisotope or enzymatic label such that binding of the compound, e.g., the substrate, to 47508 can be determined by detecting the labeled compound, e.g., substrate, in a complex. Alternatively, 47508 could be coupled with a radioisotope or enzymatic label to monitor the ability of a test compound to 20 modulate 47508 binding to a 47508 substrate in a complex. For example, compounds (e.g., 47508 substrates) can be labeled with ^{125}I , ^{35}S , ^{14}C , or ^3H , either directly or indirectly, and the radioisotope detected by direct counting of radioemission or by scintillation counting. Alternatively, compounds can be enzymatically labeled with, for example, horseradish peroxidase, alkaline phosphatase, or luciferase, and the enzymatic label detected 25 by determination of conversion of an appropriate substrate to product.

The ability of a compound (e.g., a 47508 substrate) to interact with 47508 with or without the labeling of any of the interactants can be evaluated. For example, a microphysiometer can be used to detect the interaction of a compound with 47508 without the labeling of either the compound or the 47508. McConnell, H. M. *et al.* (1992) *Science* 30 257:1906-1912. As used herein, a "microphysiometer" (e.g., Cytosensor) is an analytical instrument that measures the rate at which a cell acidifies its environment using a light-addressable potentiometric sensor (LAPS). Changes in this acidification rate can be used as an indicator of the interaction between a compound and 47508.

In yet another embodiment, a cell-free assay is provided in which a 47508 protein or biologically active portion thereof is contacted with a test compound and the ability of the test compound to bind to the 47508 protein or biologically active portion thereof is evaluated. Preferred biologically active portions of the 47508 proteins to be used in assays 5 of the present invention include fragments which participate in interactions with non-47508 molecules, e.g., fragments with high surface probability scores.

Soluble and/or membrane-bound forms of isolated proteins (e.g., 47508 proteins or biologically active portions thereof) can be used in the cell-free assays of the invention. When membrane-bound forms of the protein are used, it may be desirable to utilize a 10 solubilizing agent. Examples of such solubilizing agents include non-ionic detergents such as n-octylglucoside, n-dodecylglucoside, n-dodecylmaltoside, octanoyl-N-methylglucamide, decanoyl-N-methylglucamide, Triton® X-100, Triton® X-114, Thesit®, Isotridecyglycopol(ethylene glycol ether)_n, 3-[(3-cholamidopropyl)dimethylammonio]-1-propane sulfonate (CHAPS), 3-[(3-cholamidopropyl)dimethylammonio]-2-hydroxy-1-propane sulfonate (CHAPSO), or N-dodecyl-N,N-dimethyl-3-ammonio-1-propane sulfonate. 15

Cell-free assays involve preparing a reaction mixture of the target gene protein and the test compound under conditions and for a time sufficient to allow the two components to interact and bind, thus forming a complex that can be removed and/or detected.

The interaction between two molecules can also be detected, e.g., using fluorescence 20 energy transfer (FET) (see, for example, Lakowicz *et al.*, U.S. Patent No. 5,631,169; Stavrianopoulos, *et al.*, U.S. Patent No. 4,868,103). A fluorophore label on the first, 'donor' molecule is selected such that its emitted fluorescent energy will be absorbed by a 25 fluorescent label on a second, 'acceptor' molecule, which in turn is able to fluoresce due to the absorbed energy. Alternately, the 'donor' protein molecule may simply utilize the natural fluorescent energy of tryptophan residues. Labels are chosen that emit different wavelengths of light, such that the 'acceptor' molecule label may be differentiated from that 30 of the 'donor'. Since the efficiency of energy transfer between the labels is related to the distance separating the molecules, the spatial relationship between the molecules can be assessed. In a situation in which binding occurs between the molecules, the fluorescent emission of the 'acceptor' molecule label in the assay should be maximal. An FET binding event can be conveniently measured through standard fluorometric detection means well known in the art (e.g., using a fluorimeter).

In another embodiment, determining the ability of the 47508 protein to bind to a target molecule can be accomplished using real-time Biomolecular Interaction Analysis (BIA) (see, e.g., Sjolander, S. and Urbaniczky, C. (1991) *Anal. Chem.* 63:2338-2345 and Szabo *et al.* (1995) *Curr. Opin. Struct. Biol.* 5:699-705). "Surface plasmon resonance" or "BIA" detects biospecific interactions in real time, without labeling any of the interactants (e.g., BIACore). Changes in the mass at the binding surface (indicative of a binding event) result in alterations of the refractive index of light near the surface (the optical phenomenon of surface plasmon resonance (SPR)), resulting in a detectable signal which can be used as an indication of real-time reactions between biological molecules.

10 In one embodiment, the target gene product or the test substance is anchored onto a solid phase. The target gene product/test compound complexes anchored on the solid phase can be detected at the end of the reaction. Preferably, the target gene product can be anchored onto a solid surface, and the test compound, (which is not anchored), can be labeled, either directly or indirectly, with detectable labels discussed herein.

15 It may be desirable to immobilize either 47508, an anti-47508 antibody or its target molecule to facilitate separation of complexed from uncomplexed forms of one or both of the proteins, as well as to accommodate automation of the assay. Binding of a test compound to a 47508 protein, or interaction of a 47508 protein with a target molecule in the presence and absence of a candidate compound, can be accomplished in any vessel suitable
20 for containing the reactants. Examples of such vessels include microtiter plates, test tubes, and micro-centrifuge tubes. In one embodiment, a fusion protein can be provided which adds a domain that allows one or both of the proteins to be bound to a matrix. For example, glutathione-S-transferase/47508 fusion proteins or glutathione-S-transferase/target fusion proteins can be adsorbed onto glutathione sepharose beads (Sigma Chemical, St. Louis, MO)
25 or glutathione derivatized microtiter plates, which are then combined with the test compound or the test compound and either the non-adsorbed target protein or 47508 protein, and the mixture incubated under conditions conducive to complex formation (e.g., at physiological conditions for salt and pH). Following incubation, the beads or microtiter plate wells are washed to remove any unbound components, the matrix immobilized in the
30 case of beads, complex determined either directly or indirectly, for example, as described above. Alternatively, the complexes can be dissociated from the matrix, and the level of 47508 binding or activity determined using standard techniques.

Other techniques for immobilizing either a 47508 protein or a target molecule on matrices include using conjugation of biotin and streptavidin. Biotinylated 47508 protein or target molecules can be prepared from biotin-NHS (N-hydroxy-succinimide) using techniques known in the art (e.g., biotinylation kit, Pierce Chemicals, Rockford, IL), and 5 immobilized in the wells of streptavidin-coated 96 well plates (Pierce Chemical).

In order to conduct the assay, the non-immobilized component is added to the coated surface containing the anchored component. After the reaction is complete, unreacted components are removed (e.g., by washing) under conditions such that any complexes formed will remain immobilized on the solid surface. The detection of 10 complexes anchored on the solid surface can be accomplished in a number of ways. Where the previously non-immobilized component is pre-labeled, the detection of label immobilized on the surface indicates that complexes were formed. Where the previously non-immobilized component is not pre-labeled, an indirect label can be used to detect complexes anchored on the surface; e.g., using a labeled antibody specific for the 15 immobilized component (the antibody, in turn, can be directly labeled or indirectly labeled with, e.g., a labeled anti-Ig antibody).

In one embodiment, this assay is performed utilizing antibodies reactive with 47508 protein or target molecules but which do not interfere with binding of the 47508 protein to its target molecule. Such antibodies can be derivatized to the wells of the plate, and 20 unbound target or 47508 protein trapped in the wells by antibody conjugation. Methods for detecting such complexes, in addition to those described above for the GST-immobilized complexes, include immunodetection of complexes using antibodies reactive with the 47508 protein or target molecule, as well as enzyme-linked assays which rely on detecting an enzymatic activity associated with the 47508 protein or target molecule.

25 Alternatively, cell free assays can be conducted in a liquid phase. In such an assay, the reaction products are separated from unreacted components, by any of a number of standard techniques, including but not limited to: differential centrifugation (see, for example, Rivas, G., and Minton, A.P., (1993) *Trends Biochem Sci* 18:284-7); chromatography (gel filtration chromatography, ion-exchange chromatography); 30 electrophoresis (see, e.g., Ausubel, F. *et al.*, eds. *Current Protocols in Molecular Biology* 1999, J. Wiley: New York.); and immunoprecipitation (see, for example, Ausubel, F. *et al.*, eds. (1999) *Current Protocols in Molecular Biology*, J. Wiley: New York). Such resins and chromatographic techniques are known to one skilled in the art (see, e.g., Heegaard, N.H.,

(1998) *J Mol Recognit* 11:141-8; Hage, D.S., and Tweed, S.A. (1997) *J Chromatogr B Biomed Sci Appl.* 699:499-525). Further, fluorescence energy transfer may also be conveniently utilized, as described herein, to detect binding without further purification of the complex from solution.

5 In a preferred embodiment, the assay includes contacting the 47508 protein or biologically active portion thereof with a known compound which binds 47508 to form an assay mixture, contacting the assay mixture with a test compound, and determining the ability of the test compound to interact with a 47508 protein, wherein determining the ability of the test compound to interact with a 47508 protein includes determining the ability of the 10 test compound to preferentially bind to 47508 or biologically active portion thereof, or to modulate the activity of a target molecule, as compared to the known compound.

The target gene products of the invention can, *in vivo*, interact with one or more cellular or extracellular macromolecules, such as proteins. For the purposes of this discussion, such cellular and extracellular macromolecules are referred to herein as "binding 15 partners." Compounds that disrupt such interactions can be useful in regulating the activity of the target gene product. Such compounds can include, but are not limited to molecules such as antibodies, peptides, and small molecules. The preferred target genes/products for use in this embodiment are the 47508 genes herein identified. In an alternative embodiment, the invention provides methods for determining the ability of the test compound to modulate 20 the activity of a 47508 protein through modulation of the activity of a downstream effector of a 47508 target molecule. For example, the activity of the effector molecule on an appropriate target can be determined, or the binding of the effector to an appropriate target can be determined, as previously described.

To identify compounds that interfere with the interaction between the target gene 25 product and its cellular or extracellular binding partner(s), a reaction mixture containing the target gene product and the binding partner is prepared, under conditions and for a time sufficient, to allow the two products to form complex. In order to test an inhibitory agent, the reaction mixture is provided in the presence and absence of the test compound. The test compound can be initially included in the reaction mixture, or can be added at a time 30 subsequent to the addition of the target gene and its cellular or extracellular binding partner. Control reaction mixtures are incubated without the test compound or with a placebo. The formation of any complexes between the target gene product and the cellular or extracellular binding partner is then detected. The formation of a complex in the control reaction, but not

in the reaction mixture containing the test compound, indicates that the compound interferes with the interaction of the target gene product and the interactive binding partner. Additionally, complex formation within reaction mixtures containing the test compound and normal target gene product can also be compared to complex formation within reaction mixtures containing the test compound and mutant target gene product. This comparison can be important in those cases wherein it is desirable to identify compounds that disrupt interactions of mutant but not normal target gene products.

These assays can be conducted in a heterogeneous or homogeneous format. Heterogeneous assays involve anchoring either the target gene product or the binding partner onto a solid phase, and detecting complexes anchored on the solid phase at the end of the reaction. In homogeneous assays, the entire reaction is carried out in a liquid phase. In either approach, the order of addition of reactants can be varied to obtain different information about the compounds being tested. For example, test compounds that interfere with the interaction between the target gene products and the binding partners, e.g., by competition, can be identified by conducting the reaction in the presence of the test substance. Alternatively, test compounds that disrupt preformed complexes, e.g., compounds with higher binding constants that displace one of the components from the complex, can be tested by adding the test compound to the reaction mixture after complexes have been formed. The various formats are briefly described below.

In a heterogeneous assay system, either the target gene product or the interactive cellular or extracellular binding partner, is anchored onto a solid surface (e.g., a microtiter plate), while the non-anchored species is labeled, either directly or indirectly. The anchored species can be immobilized by non-covalent or covalent attachments. Alternatively, an immobilized antibody specific for the species to be anchored can be used to anchor the species to the solid surface.

In order to conduct the assay, the partner of the immobilized species is exposed to the coated surface with or without the test compound. After the reaction is complete, unreacted components are removed (e.g., by washing) and any complexes formed will remain immobilized on the solid surface. Where the non-immobilized species is pre-labeled, the detection of label immobilized on the surface indicates that complexes were formed. Where the non-immobilized species is not pre-labeled, an indirect label can be used to detect complexes anchored on the surface; e.g., using a labeled antibody specific for the initially non-immobilized species (the antibody, in turn, can be directly labeled or indirectly

labeled with, e.g., a labeled anti-Ig antibody). Depending upon the order of addition of reaction components, test compounds that inhibit complex formation or that disrupt preformed complexes can be detected.

Alternatively, the reaction can be conducted in a liquid phase in the presence or 5 absence of the test compound, the reaction products separated from unreacted components, and complexes detected; e.g., using an immobilized antibody specific for one of the binding components to anchor any complexes formed in solution, and a labeled antibody specific for the other partner to detect anchored complexes. Again, depending upon the order of addition of reactants to the liquid phase, test compounds that inhibit complex or that disrupt 10 preformed complexes can be identified.

In an alternate embodiment of the invention, a homogeneous assay can be used. For example, a preformed complex of the target gene product and the interactive cellular or extracellular binding partner product is prepared in that either the target gene products or their binding partners are labeled, but the signal generated by the label is quenched due to 15 complex formation (see, e.g., U.S. Patent No. 4,109,496 that utilizes this approach for immunoassays). The addition of a test substance that competes with and displaces one of the species from the preformed complex will result in the generation of a signal above background. In this way, test substances that disrupt target gene product-binding partner interaction can be identified.

20 In yet another aspect, the 47508 proteins can be used as "bait proteins" in a two-hybrid assay or three-hybrid assay (see, e.g., U.S. Patent No. 5,283,317; Zervos *et al.* (1993) *Cell* 72:223-232; Madura *et al.* (1993) *J. Biol. Chem.* 268:12046-12054; Bartel *et al.* (1993) *Biotechniques* 14:920-924; Iwabuchi *et al.* (1993) *Oncogene* 8:1693-1696; and Brent WO94/10300), to identify other proteins, which bind to or interact with 47508 ("47508- 25 binding proteins" or "47508-bp") and are involved in 47508 activity. Such 47508-bps can be activators or inhibitors of signals by the 47508 proteins or 47508 targets as, for example, downstream elements of a 47508-mediated signaling pathway.

The two-hybrid system is based on the modular nature of most transcription factors, which consist of separable DNA-binding and activation domains. Briefly, the assay utilizes 30 two different DNA constructs. In one construct, the gene that codes for a 47508 protein is fused to a gene encoding the DNA binding domain of a known transcription factor (e.g., GAL-4). In the other construct, a DNA sequence, from a library of DNA sequences, that encodes an unidentified protein ("prey" or "sample") is fused to a gene that codes for the

activation domain of the known transcription factor. (Alternatively the 47508 protein can be fused to the activator domain.) If the "bait" and the "prey" proteins are able to interact, *in vivo*, forming a 47508-dependent complex, the DNA-binding and activation domains of the transcription factor are brought into close proximity. This proximity allows 5 transcription of a reporter gene (e.g., lacZ) which is operably linked to a transcriptional regulatory site responsive to the transcription factor. Expression of the reporter gene can be detected and cell colonies containing the functional transcription factor can be isolated and used to obtain the cloned gene which encodes the protein which interacts with the 47508 protein.

10 In another embodiment, modulators of 47508 expression are identified. For example, a cell or cell free mixture is contacted with a candidate compound and the expression of 47508 mRNA or protein evaluated relative to the level of expression of 47508 mRNA or protein in the absence of the candidate compound. When expression of 47508 mRNA or protein is greater in the presence of the candidate compound than in its absence, 15 the candidate compound is identified as a stimulator of 47508 mRNA or protein expression. Alternatively, when expression of 47508 mRNA or protein is less (statistically significantly less) in the presence of the candidate compound than in its absence, the candidate compound is identified as an inhibitor of 47508 mRNA or protein expression. The level of 47508 mRNA or protein expression can be determined by methods described herein for detecting 20 47508 mRNA or protein.

In another aspect, the invention pertains to a combination of two or more of the assays described herein. For example, a modulating agent can be identified using a cell-based or a cell free assay, and the ability of the agent to modulate the activity of a 47508 protein can be confirmed *in vivo*, e.g., in an animal such as an animal model for a cellular 25 proliferative and/or differentiative disorder.

This invention further pertains to novel agents identified by the above-described screening assays. Accordingly, it is within the scope of this invention to further use an agent identified as described herein (e.g., a 47508 modulating agent, an antisense 47508 nucleic acid molecule, a 47508-specific antibody, or a 47508-binding partner) in an appropriate 30 animal model to determine the efficacy, toxicity, side effects, or mechanism of action, of treatment with such an agent. Furthermore, novel agents identified by the above-described screening assays can be used for treatments as described herein.

Detection Assays

Portions or fragments of the nucleic acid sequences identified herein can be used as polynucleotide reagents. For example, these sequences can be used to: (i) map their respective genes on a chromosome e.g., to locate gene regions associated with genetic 5 disease or to associate 47508 with a disease; (ii) identify an individual from a minute biological sample (tissue typing); and (iii) aid in forensic identification of a biological sample. These applications are described in the subsections below.

Chromosome Mapping

The 47508 nucleotide sequences or portions thereof can be used to map the location 10 of the 47508 genes on a chromosome. This process is called chromosome mapping. Chromosome mapping is useful in correlating the 47508 sequences with genes associated with disease.

Briefly, 47508 genes can be mapped to chromosomes by preparing PCR primers (preferably 15-25 bp in length) from the 47508 nucleotide sequences. These primers can 15 then be used for PCR screening of somatic cell hybrids containing individual human chromosomes. Only those hybrids containing the human gene corresponding to the 47508 sequences will yield an amplified fragment.

A panel of somatic cell hybrids in which each cell line contains either a single human 20 chromosome or a small number of human chromosomes, and a full set of mouse chromosomes, can allow easy mapping of individual genes to specific human chromosomes. (D'Eustachio P. *et al.* (1983) *Science* 220:919-924).

Other mapping strategies e.g., *in situ* hybridization (described in Fan, Y. *et al.* (1990) *Proc. Natl. Acad. Sci. USA*, 87:6223-27), pre-screening with labeled flow-sorted 25 chromosomes, and pre-selection by hybridization to chromosome specific cDNA libraries can be used to map 47508 to a chromosomal location.

Fluorescence *in situ* hybridization (FISH) of a DNA sequence to a metaphase 30 chromosomal spread can further be used to provide a precise chromosomal location in one step. The FISH technique can be used with a DNA sequence as short as 500 or 600 bases. However, clones larger than 1,000 bases have a higher likelihood of binding to a unique chromosomal location with sufficient signal intensity for simple detection. Preferably 1,000 bases, and more preferably 2,000 bases will suffice to get good results at a reasonable

amount of time. For a review of this technique, see Verma *et al.*, Human Chromosomes: A Manual of Basic Techniques ((1988) Pergamon Press, New York).

Reagents for chromosome mapping can be used individually to mark a single chromosome or a single site on that chromosome, or panels of reagents can be used for 5 marking multiple sites and/or multiple chromosomes. Reagents corresponding to noncoding regions of the genes actually are preferred for mapping purposes. Coding sequences are more likely to be conserved within gene families, thus increasing the chance of cross hybridizations during chromosomal mapping.

Once a sequence has been mapped to a precise chromosomal location, the physical 10 position of the sequence on the chromosome can be correlated with genetic map data. (Such data are found, for example, in V. McKusick, Mendelian Inheritance in Man, available online through Johns Hopkins University Welch Medical Library). The relationship between a gene and a disease, mapped to the same chromosomal region, can then be identified through linkage analysis (co-inheritance of physically adjacent genes), described in, for example, 15 Egeland, J. *et al.* (1987) *Nature*, 325:783-787.

Moreover, differences in the DNA sequences between individuals affected and 20 unaffected with a disease associated with the 47508 gene, can be determined. If a mutation is observed in some or all of the affected individuals but not in any unaffected individuals, then the mutation is likely to be the causative agent of the particular disease. Comparison of affected and unaffected individuals generally involves first looking for structural alterations in the chromosomes, such as deletions or translocations that are visible from chromosome spreads or detectable using PCR based on that DNA sequence. Ultimately, complete sequencing of genes from several individuals can be performed to confirm the presence of a mutation and to distinguish mutations from polymorphisms.

25 Tissue Typing

47508 sequences can be used to identify individuals from biological samples using, e.g., restriction fragment length polymorphism (RFLP). In this technique, an individual's 30 genomic DNA is digested with one or more restriction enzymes, the fragments separated, e.g., in a Southern blot, and probed to yield bands for identification. The sequences of the present invention are useful as additional DNA markers for RFLP (described in U.S. Patent 5,272,057).

Furthermore, the sequences of the present invention can also be used to determine the actual base-by-base DNA sequence of selected portions of an individual's genome. Thus, the 47508 nucleotide sequences described herein can be used to prepare two PCR primers from the 5' and 3' ends of the sequences. These primers can then be used to amplify 5 an individual's DNA and subsequently sequence it. Panels of corresponding DNA sequences from individuals, prepared in this manner, can provide unique individual identifications, as each individual will have a unique set of such DNA sequences due to allelic differences.

Allelic variation occurs to some degree in the coding regions of these sequences, and 10 to a greater degree in the noncoding regions. Each of the sequences described herein can, to some degree, be used as a standard against which DNA from an individual can be compared for identification purposes. Because greater numbers of polymorphisms occur in the noncoding regions, fewer sequences are necessary to differentiate individuals. The noncoding sequences of SEQ ID NO:1 can provide positive individual identification with a 15 panel of perhaps 10 to 1,000 primers which each yield a noncoding amplified sequence of 100 bases. If predicted coding sequences, such as those in SEQ ID NO:3 are used, a more appropriate number of primers for positive individual identification would be 500-2,000.

If a panel of reagents from 47508 nucleotide sequences described herein is used to generate a unique identification database for an individual, those same reagents can later be 20 used to identify tissue from that individual. Using the unique identification database, positive identification of the individual, living or dead, can be made from extremely small tissue samples.

Use of Partial 47508 Sequences in Forensic Biology

DNA-based identification techniques can also be used in forensic biology. To make 25 such an identification, PCR technology can be used to amplify DNA sequences taken from very small biological samples such as tissues, e.g., hair or skin, or body fluids, e.g., blood, saliva, or semen found at a crime scene. The amplified sequence can then be compared to a standard, thereby allowing identification of the origin of the biological sample.

The sequences of the present invention can be used to provide polynucleotide 30 reagents, e.g., PCR primers, targeted to specific loci in the human genome, which can enhance the reliability of DNA-based forensic identifications by, for example, providing another "identification marker" (i.e. another DNA sequence that is unique to a particular

individual). As mentioned above, actual base sequence information can be used for identification as an accurate alternative to patterns formed by restriction enzyme generated fragments. Sequences targeted to noncoding regions of SEQ ID NO:1 (e.g., fragments derived from the noncoding regions of SEQ ID NO:1 having a length of at least 20 bases, 5 preferably at least 30 bases) are particularly appropriate for this use.

The 47508 nucleotide sequences described herein can further be used to provide polynucleotide reagents, e.g., labeled or labelable probes which can be used in, for example, an *in situ* hybridization technique, to identify a specific tissue. This can be very useful in cases where a forensic pathologist is presented with a tissue of unknown origin. Panels of 10 such 47508 probes can be used to identify tissue by species and/or by organ type.

In a similar fashion, these reagents, e.g., 47508 primers or probes can be used to screen tissue culture for contamination (i.e. screen for the presence of a mixture of different types of cells in a culture).

Predictive Medicine

15 The present invention also pertains to the field of predictive medicine in which diagnostic assays, prognostic assays, and monitoring clinical trials are used for prognostic (predictive) purposes to thereby treat an individual.

Generally, the invention provides, a method of determining if a subject is at risk for a disorder related to a lesion in or the misexpression of a gene which encodes 47508.

20 Such disorders include, e.g., a disorder associated with the misexpression of 47508 gene, e.g., a cellular proliferative and/or differentiative disorder.

The method includes one or more of the following:

25 detecting, in a tissue of the subject, the presence or absence of a mutation which affects the expression of the 47508 gene, or detecting the presence or absence of a mutation in a region which controls the expression of the gene, e.g., a mutation in the 5' control region;

detecting, in a tissue of the subject, the presence or absence of a mutation which alters the structure of the 47508 gene;

30 detecting, in a tissue of the subject, the misexpression of the 47508 gene, at the mRNA level, e.g., detecting a non-wild type level of a mRNA ;

detecting, in a tissue of the subject, the misexpression of the gene, at the protein level, e.g., detecting a non-wild type level of a 47508 polypeptide.

In preferred embodiments the method includes: ascertaining the existence of at least one of: a deletion of one or more nucleotides from the 47508 gene; an insertion of one or more nucleotides into the gene, a point mutation, e.g., a substitution of one or more nucleotides of the gene, a gross chromosomal rearrangement of the gene, e.g., a 5 translocation, inversion, or deletion.

For example, detecting the genetic lesion can include: (i) providing a probe/primer including an oligonucleotide containing a region of nucleotide sequence which hybridizes to a sense or antisense sequence from SEQ ID NO:1, or naturally occurring mutants thereof or 5' or 3' flanking sequences naturally associated with the 47508 gene; (ii) exposing the 10 probe/primer to nucleic acid of the tissue; and detecting, by hybridization, e.g., *in situ* hybridization, of the probe/primer to the nucleic acid, the presence or absence of the genetic lesion.

In preferred embodiments detecting the misexpression includes ascertaining the 15 existence of at least one of: an alteration in the level of a messenger RNA transcript of the 47508 gene; the presence of a non-wild type splicing pattern of a messenger RNA transcript of the gene; or a non-wild type level of 47508.

Methods of the invention can be used prenatally or to determine if a subject's offspring will be at risk for a disorder.

20 In preferred embodiments the method includes determining the structure of a 47508 gene, an abnormal structure being indicative of risk for the disorder.

In preferred embodiments the method includes contacting a sample from the subject with an antibody to the 47508 protein or a nucleic acid, which hybridizes specifically with the gene. These and other embodiments are discussed below.

Diagnostic and Prognostic Assays

25 Diagnostic and prognostic assays of the invention include method for assessing the expression level of 47508 molecules and for identifying variations and mutations in the sequence of 47508 molecules.

30 Expression Monitoring and Profiling. The presence, level, or absence of 47508 protein or nucleic acid in a biological sample can be evaluated by obtaining a biological sample from a test subject and contacting the biological sample with a compound or an agent capable of detecting 47508 protein or nucleic acid (e.g., mRNA, genomic DNA) that encodes 47508 protein such that the presence of 47508 protein or nucleic acid is detected in

the biological sample. The term "biological sample" includes tissues, cells and biological fluids isolated from a subject, as well as tissues, cells and fluids present within a subject. A preferred biological sample is serum. The level of expression of the 47508 gene can be measured in a number of ways, including, but not limited to: measuring the mRNA encoded by the 47508 genes; measuring the amount of protein encoded by the 47508 genes; or measuring the activity of the protein encoded by the 47508 genes.

5 The level of mRNA corresponding to the 47508 gene in a cell can be determined both by *in situ* and by *in vitro* formats.

10 The isolated mRNA can be used in hybridization or amplification assays that include, but are not limited to, Southern or Northern analyses, polymerase chain reaction analyses and probe arrays. One preferred diagnostic method for the detection of mRNA levels involves contacting the isolated mRNA with a nucleic acid molecule (probe) that can hybridize to the mRNA encoded by the gene being detected. The nucleic acid probe can be, for example, a full-length 47508 nucleic acid, such as the nucleic acid of SEQ ID NO:1, or a 15 portion thereof, such as an oligonucleotide of at least 7, 15, 30, 50, 100, 250 or 500 nucleotides in length and sufficient to specifically hybridize under stringent conditions to 47508 mRNA or genomic DNA. The probe can be disposed on an address of an array, e.g., an array described below. Other suitable probes for use in the diagnostic assays are described herein.

20 In one format, mRNA (or cDNA) is immobilized on a surface and contacted with the probes, for example by running the isolated mRNA on an agarose gel and transferring the mRNA from the gel to a membrane, such as nitrocellulose. In an alternative format, the probes are immobilized on a surface and the mRNA (or cDNA) is contacted with the probes, for example, in a two-dimensional gene chip array described below. A skilled artisan can 25 adapt known mRNA detection methods for use in detecting the level of mRNA encoded by the 47508 genes.

30 The level of mRNA in a sample that is encoded by one of 47508 can be evaluated with nucleic acid amplification, e.g., by rtPCR (Mullis (1987) U.S. Patent No. 4,683,202), ligase chain reaction (Barany (1991) *Proc. Natl. Acad. Sci. USA* 88:189-193), self sustained sequence replication (Guatelli *et al.*, (1990) *Proc. Natl. Acad. Sci. USA* 87:1874-1878), transcriptional amplification system (Kwoh *et al.*, (1989), *Proc. Natl. Acad. Sci. USA* 86:1173-1177), Q-Beta Replicase (Lizardi *et al.*, (1988) *Bio/Technology* 6:1197), rolling circle replication (Lizardi *et al.*, U.S. Patent No. 5,854,033) or any other nucleic acid

amplification method, followed by the detection of the amplified molecules using techniques known in the art. As used herein, amplification primers are defined as being a pair of nucleic acid molecules that can anneal to 5' or 3' regions of a gene (plus and minus strands, respectively, or vice-versa) and contain a short region in between. In general, amplification 5 primers are from about 10 to 30 nucleotides in length and flank a region from about 50 to 200 nucleotides in length. Under appropriate conditions and with appropriate reagents, such primers permit the amplification of a nucleic acid molecule comprising the nucleotide sequence flanked by the primers.

For *in situ* methods, a cell or tissue sample can be prepared/processed and 10 immobilized on a support, typically a glass slide, and then contacted with a probe that can hybridize to mRNA that encodes the 47508 gene being analyzed.

In another embodiment, the methods further contacting a control sample with a compound or agent capable of detecting 47508 mRNA, or genomic DNA, and comparing the presence of 47508 mRNA or genomic DNA in the control sample with the presence of 15 47508 mRNA or genomic DNA in the test sample. In still another embodiment, serial analysis of gene expression, as described in U.S. Patent No. 5,695,937, is used to detect 47508 transcript levels.

A variety of methods can be used to determine the level of protein encoded by 47508. In general, these methods include contacting an agent that selectively binds to the 20 protein, such as an antibody with a sample, to evaluate the level of protein in the sample. In a preferred embodiment, the antibody bears a detectable label. Antibodies can be polyclonal, or more preferably, monoclonal. An intact antibody, or a fragment thereof (e.g., Fab or F(ab')₂) can be used. The term "labeled", with regard to the probe or antibody, is intended to encompass direct labeling of the probe or antibody by coupling (i.e., physically 25 linking) a detectable substance to the probe or antibody, as well as indirect labeling of the probe or antibody by reactivity with a detectable substance. Examples of detectable substances are provided herein.

The detection methods can be used to detect 47508 protein in a biological sample *in vitro* as well as *in vivo*. *In vitro* techniques for detection of 47508 protein include enzyme 30 linked immunosorbent assays (ELISAs), immunoprecipitations, immunofluorescence, enzyme immunoassay (EIA), radioimmunoassay (RIA), and Western blot analysis. *In vivo* techniques for detection of 47508 protein include introducing into a subject a labeled anti-47508 antibody. For example, the antibody can be labeled with a radioactive marker whose

presence and location in a subject can be detected by standard imaging techniques. In another embodiment, the sample is labeled, e.g., biotinylated and then contacted to the antibody, e.g., an anti-47508 antibody positioned on an antibody array (as described below). The sample can be detected, e.g., with avidin coupled to a fluorescent label.

5 In another embodiment, the methods further include contacting the control sample with a compound or agent capable of detecting 47508 protein, and comparing the presence of 47508 protein in the control sample with the presence of 47508 protein in the test sample.

The invention also includes kits for detecting the presence of 47508 in a biological sample. For example, the kit can include a compound or agent capable of detecting 47508 10 protein or mRNA in a biological sample; and a standard. The compound or agent can be packaged in a suitable container. The kit can further comprise instructions for using the kit to detect 47508 protein or nucleic acid.

For antibody-based kits, the kit can include: (1) a first antibody (e.g., attached to a solid support) which binds to a polypeptide corresponding to a marker of the invention; and, 15 optionally, (2) a second, different antibody which binds to either the polypeptide or the first antibody and is conjugated to a detectable agent.

For oligonucleotide-based kits, the kit can include: (1) an oligonucleotide, e.g., a detectably labeled oligonucleotide, which hybridizes to a nucleic acid sequence encoding a polypeptide corresponding to a marker of the invention or (2) a pair of primers useful for 20 amplifying a nucleic acid molecule corresponding to a marker of the invention. The kit can also includes a buffering agent, a preservative, or a protein stabilizing agent. The kit can also includes components necessary for detecting the detectable agent (e.g., an enzyme or a substrate). The kit can also contain a control sample or a series of control samples which can be assayed and compared to the test sample contained. Each component of the kit can 25 be enclosed within an individual container and all of the various containers can be within a single package, along with instructions for interpreting the results of the assays performed using the kit.

The diagnostic methods described herein can identify subjects having, or at risk of developing, a disease or disorder associated with misexpressed or aberrant or unwanted 30 47508 expression or activity. As used herein, the term "unwanted" includes an unwanted phenomenon involved in a biological response such as a cellular proliferative and/or differentiative disorder.

In one embodiment, a disease or disorder associated with aberrant or unwanted 47508 expression or activity is identified. A test sample is obtained from a subject and 47508 protein or nucleic acid (e.g., mRNA or genomic DNA) is evaluated, wherein the level, e.g., the presence or absence, of 47508 protein or nucleic acid is diagnostic for a 5 subject having or at risk of developing a disease or disorder associated with aberrant or unwanted 47508 expression or activity. As used herein, a "test sample" refers to a biological sample obtained from a subject of interest, including a biological fluid (e.g., serum), cell sample, or tissue.

The prognostic assays described herein can be used to determine whether a subject 10 can be administered an agent (e.g., an agonist, antagonist, peptidomimetic, protein, peptide, nucleic acid, small molecule, or other drug candidate) to treat a disease or disorder associated with aberrant or unwanted 47508 expression or activity. For example, such methods can be used to determine whether a subject can be effectively treated with an agent for, e.g., a cellular proliferative and/or differentiative disorder.

15 In another aspect, the invention features a computer medium having a plurality of digitally encoded data records. Each data record includes a value representing the level of expression of 47508 in a sample, and a descriptor of the sample. The descriptor of the sample can be an identifier of the sample, a subject from which the sample was derived (e.g., a patient), a diagnosis, or a treatment (e.g., a preferred treatment). In a preferred 20 embodiment, the data record further includes values representing the level of expression of genes other than 47508 (e.g., other genes associated with a 47508-disorder, or other genes on an array). The data record can be structured as a table, e.g., a table that is part of a database such as a relational database (e.g., a SQL database of the Oracle or Sybase database environments).

25 Also featured is a method of evaluating a sample. The method includes providing a sample, e.g., from the subject, and determining a gene expression profile of the sample, wherein the profile includes a value representing the level of 47508 expression. The method can further include comparing the value or the profile (i.e., multiple values) to a reference value or reference profile. The gene expression profile of the sample can be 30 obtained by any of the methods described herein (e.g., by providing a nucleic acid from the sample and contacting the nucleic acid to an array). The method can be used to diagnose a cellular proliferative and/or differentiative disorder in a subject wherein an increase in 47508 expression is an indication that the subject has or is disposed to having a cellular

proliferative and/or differentiative disorder. The method can be used to monitor a treatment for a cellular proliferative and/or differentiative disorder in a subject. For example, the gene expression profile can be determined for a sample from a subject undergoing treatment. The profile can be compared to a reference profile or to a profile obtained from the subject prior to treatment or prior to onset of the disorder (see, e.g., Golub *et al.* (1999) *Science* 286:531).

5 In yet another aspect, the invention features a method of evaluating a test compound (see also, "Screening Assays", above). The method includes providing a cell and a test compound; contacting the test compound to the cell; obtaining a subject expression profile for the contacted cell; and comparing the subject expression profile to one or more reference profiles. The profiles include a value representing the level of 47508 expression. In a 10 preferred embodiment, the subject expression profile is compared to a target profile, e.g., a profile for a normal cell or for desired condition of a cell. The test compound is evaluated favorably if the subject expression profile is more similar to the target profile than an expression profile obtained from an uncontacted cell.

15 In another aspect, the invention features, a method of evaluating a subject. The method includes: a) obtaining a sample from a subject, e.g., from a caregiver, e.g., a caregiver who obtains the sample from the subject; b) determining a subject expression profile for the sample. Optionally, the method further includes either or both of steps: c) comparing the subject expression profile to one or more reference expression profiles; and 20 d) selecting the reference profile most similar to the subject reference profile. The subject expression profile and the reference profiles include a value representing the level of 47508 expression. A variety of routine statistical measures can be used to compare two reference profiles. One possible metric is the length of the distance vector that is the difference between the two profiles. Each of the subject and reference profile is represented as a multi-dimensional vector, wherein each dimension is a value in the profile.

25 The method can further include transmitting a result to a caregiver. The result can be the subject expression profile, a result of a comparison of the subject expression profile with another profile, a most similar reference profile, or a descriptor of any of the aforementioned. The result can be transmitted across a computer network, e.g., the result 30 can be in the form of a computer transmission, e.g., a computer data signal embedded in a carrier wave.

Also featured is a computer medium having executable code for effecting the following steps: receive a subject expression profile; access a database of reference

expression profiles; and either i) select a matching reference profile most similar to the subject expression profile or ii) determine at least one comparison score for the similarity of the subject expression profile to at least one reference profile. The subject expression profile, and the reference expression profiles each include a value representing the level of 5 47508 expression.

Arrays and Uses Thereof

In another aspect, the invention features an array that includes a substrate having a plurality of addresses. At least one address of the plurality includes a capture probe that binds specifically to a 47508 molecule (e.g., a 47508 nucleic acid or a 47508 polypeptide). 10 The array can have a density of at least than 10, 50, 100, 200, 500, 1,000, 2,000, or 10,000 or more addresses/cm², and ranges between. In a preferred embodiment, the plurality of addresses includes at least 10, 100, 500, 1,000, 5,000, 10,000, 50,000 addresses. In a 15 preferred embodiment, the plurality of addresses includes equal to or less than 10, 100, 500, 1,000, 5,000, 10,000, or 50,000 addresses. The substrate can be a two-dimensional substrate such as a glass slide, a wafer (e.g., silica or plastic), a mass spectroscopy plate, or a three-dimensional substrate such as a gel pad. Addresses in addition to address of the plurality 20 can be disposed on the array.

In a preferred embodiment, at least one address of the plurality includes a nucleic acid capture probe that hybridizes specifically to a 47508 nucleic acid, e.g., the sense or anti-sense strand. In one preferred embodiment, a subset of addresses of the plurality of addresses has a nucleic acid capture probe for 47508. Each address of the subset can include a capture probe that hybridizes to a different region of a 47508 nucleic acid. In another preferred embodiment, addresses of the subset include a capture probe for a 47508 nucleic acid. Each address of the subset is unique, overlapping, and complementary to a different 25 variant of 47508 (e.g., an allelic variant, or all possible hypothetical variants). The array can be used to sequence 47508 by hybridization (see, e.g., U.S. Patent No. 5,695,940).

An array can be generated by various methods, e.g., by photolithographic methods (see, e.g., U.S. Patent Nos. 5,143,854; 5,510,270; and 5,527,681), mechanical methods (e.g., directed-flow methods as described in U.S. Patent No. 5,384,261), pin-based methods (e.g., 30 as described in U.S. Pat. No. 5,288,514), and bead-based techniques (e.g., as described in PCT US/93/04145). :

In another preferred embodiment, at least one address of the plurality includes a polypeptide capture probe that binds specifically to a 47508 polypeptide or fragment thereof. The polypeptide can be a naturally-occurring interaction partner of 47508 polypeptide. Preferably, the polypeptide is an antibody, e.g., an antibody described herein (see "Anti-47508 Antibodies," above), such as a monoclonal antibody or a single-chain antibody.

5 In another aspect, the invention features a method of analyzing the expression of 47508. The method includes providing an array as described above; contacting the array with a sample and detecting binding of a 47508-molecule (e.g., nucleic acid or polypeptide) to the array. In a preferred embodiment, the array is a nucleic acid array. Optionally the 10 method further includes amplifying nucleic acid from the sample prior or during contact with the array.

15 In another embodiment, the array can be used to assay gene expression in a tissue to ascertain tissue specificity of genes in the array, particularly the expression of 47508. If a sufficient number of diverse samples is analyzed, clustering (e.g., hierarchical clustering, k-means clustering, Bayesian clustering and the like) can be used to identify other genes which are co-regulated with 47508. For example, the array can be used for the quantitation of the expression of multiple genes. Thus, not only tissue specificity, but also the level of expression of a battery of genes in the tissue is ascertained. Quantitative data can be used to group (e.g., cluster) genes on the basis of their tissue expression *per se* and level of 20 expression in that tissue.

25 For example, array analysis of gene expression can be used to assess the effect of cell-cell interactions on 47508 expression. A first tissue can be perturbed and nucleic acid from a second tissue that interacts with the first tissue can be analyzed. In this context, the effect of one cell type on another cell type in response to a biological stimulus can be determined, e.g., to monitor the effect of cell-cell interaction at the level of gene expression.

30 In another embodiment, cells are contacted with a therapeutic agent. The expression profile of the cells is determined using the array, and the expression profile is compared to the profile of like cells not contacted with the agent. For example, the assay can be used to determine or analyze the molecular basis of an undesirable effect of the therapeutic agent. If an agent is administered therapeutically to treat one cell type but has an undesirable effect on another cell type, the invention provides an assay to determine the molecular basis of the undesirable effect and thus provides the opportunity to co-administer a counteracting agent or otherwise treat the undesired effect. Similarly, even within a single cell type, undesirable

biological effects can be determined at the molecular level. Thus, the effects of an agent on expression of other than the target gene can be ascertained and counteracted.

In another embodiment, the array can be used to monitor expression of one or more genes in the array with respect to time. For example, samples obtained from different time 5 points can be probed with the array. Such analysis can identify and/or characterize the development of a 47508-associated disease or disorder; and processes, such as a cellular transformation associated with a 47508-associated disease or disorder. The method can also evaluate the treatment and/or progression of a 47508-associated disease or disorder

The array is also useful for ascertaining differential expression patterns of one or 10 more genes in normal and abnormal cells. This provides a battery of genes (e.g., including 47508) that could serve as a molecular target for diagnosis or therapeutic intervention.

In another aspect, the invention features an array having a plurality of addresses. Each address of the plurality includes a unique polypeptide. At least one address of the plurality has disposed thereon a 47508 polypeptide or fragment thereof. Methods of 15 producing polypeptide arrays are described in the art, e.g., in De Wildt *et al.* (2000). *Nature Biotech.* 18, 989-994; Lueking *et al.* (1999). *Anal. Biochem.* 270, 103-111; Ge, H. (2000). *Nucleic Acids Res.* 28, e3, I-VII; MacBeath, G., and Schreiber, S.L. (2000). *Science* 289, 1760-1763; and WO 99/51773A1. In a preferred embodiment, each addresses of the plurality has disposed thereon a polypeptide at least 60, 70, 80, 85, 90, 95 or 99 % identical 20 to a 47508 polypeptide or fragment thereof. For example, multiple variants of a 47508 polypeptide (e.g., encoded by allelic variants, site-directed mutants, random mutants, or combinatorial mutants) can be disposed at individual addresses of the plurality. Addresses in addition to the address of the plurality can be disposed on the array.

The polypeptide array can be used to detect a 47508 binding compound, e.g., an 25 antibody in a sample from a subject with specificity for a 47508 polypeptide or the presence of a 47508-binding protein or ligand.

The array is also useful for ascertaining the effect of the expression of a gene on the expression of other genes in the same cell or in different cells (e.g., ascertaining the effect of 47508 expression on the expression of other genes). This provides, for example, for a 30 selection of alternate molecular targets for therapeutic intervention if the ultimate or downstream target cannot be regulated.

In another aspect, the invention features a method of analyzing a plurality of probes. The method is useful, e.g., for analyzing gene expression. The method includes: providing

a two dimensional array having a plurality of addresses, each address of the plurality being positionally distinguishable from each other address of the plurality having a unique capture probe, e.g., wherein the capture probes are from a cell or subject which express 47508 or from a cell or subject in which a 47508 mediated response has been elicited, e.g., by contact of the cell with 47508 nucleic acid or protein, or administration to the cell or subject 47508 nucleic acid or protein; providing a two dimensional array having a plurality of addresses, each address of the plurality being positionally distinguishable from each other address of the plurality, and each address of the plurality having a unique capture probe, e.g., wherein the capture probes are from a cell or subject which does not express 47508 (or does not express as highly as in the case of the 47508 positive plurality of capture probes) or from a cell or subject which in which a 47508 mediated response has not been elicited (or has been elicited to a lesser extent than in the first sample); contacting the array with one or more inquiry probes (which is preferably other than a 47508 nucleic acid, polypeptide, or antibody), and thereby evaluating the plurality of capture probes. Binding, e.g., in the case of a nucleic acid, hybridization with a capture probe at an address of the plurality, is detected, e.g., by signal generated from a label attached to the nucleic acid, polypeptide, or antibody.

In another aspect, the invention features a method of analyzing a plurality of probes or a sample. The method is useful, e.g., for analyzing gene expression. The method includes: providing a two dimensional array having a plurality of addresses, each address of the plurality being positionally distinguishable from each other address of the plurality having a unique capture probe, contacting the array with a first sample from a cell or subject which express or mis-express 47508 or from a cell or subject in which a 47508-mediated response has been elicited, e.g., by contact of the cell with 47508 nucleic acid or protein, or administration to the cell or subject 47508 nucleic acid or protein; providing a two dimensional array having a plurality of addresses, each address of the plurality being positionally distinguishable from each other address of the plurality, and each address of the plurality having a unique capture probe, and contacting the array with a second sample from a cell or subject which does not express 47508 (or does not express as highly as in the case of the 47508 positive plurality of capture probes) or from a cell or subject which in which a 47508 mediated response has not been elicited (or has been elicited to a lesser extent than in the first sample); and comparing the binding of the first sample with the binding of the second sample. Binding, e.g., in the case of a nucleic acid, hybridization with a capture

probe at an address of the plurality, is detected, e.g., by signal generated from a label attached to the nucleic acid, polypeptide, or antibody. The same array can be used for both samples or different arrays can be used. If different arrays are used the plurality of addresses with capture probes should be present on both arrays.

5 In another aspect, the invention features a method of analyzing 47508, e.g., analyzing structure, function, or relatedness to other nucleic acid or amino acid sequences. The method includes: providing a 47508 nucleic acid or amino acid sequence; comparing the 47508 sequence with one or more preferably a plurality of sequences from a collection of sequences, e.g., a nucleic acid or protein sequence database; to thereby analyze 47508.

10 Detection of Variations or Mutations

The methods of the invention can also be used to detect genetic alterations in a 47508 gene, thereby determining if a subject with the altered gene is at risk for a disorder characterized by misregulation in 47508 protein activity or nucleic acid expression, such as a cellular proliferative and/or differentiative disorder. In preferred embodiments, the 15 methods include detecting, in a sample from the subject, the presence or absence of a genetic alteration characterized by at least one of an alteration affecting the integrity of a gene encoding a 47508-protein, or the mis-expression of the 47508 gene. For example, such genetic alterations can be detected by ascertaining the existence of at least one of 1) a deletion of one or more nucleotides from a 47508 gene; 2) an addition of one or more 20 nucleotides to a 47508 gene; 3) a substitution of one or more nucleotides of a 47508 gene, 4) a chromosomal rearrangement of a 47508 gene; 5) an alteration in the level of a messenger RNA transcript of a 47508 gene, 6) aberrant modification of a 47508 gene, such as of the methylation pattern of the genomic DNA, 7) the presence of a non-wild type splicing pattern of a messenger RNA transcript of a 47508 gene, 8) a non-wild type level of a 47508-protein, 25 9) allelic loss of a 47508 gene, and 10) inappropriate post-translational modification of a 47508-protein.

An alteration can be detected without a probe/primer in a polymerase chain reaction, such as anchor PCR or RACE PCR, or, alternatively, in a ligation chain reaction (LCR), the latter of which can be particularly useful for detecting point mutations in the 47508-gene. 30 This method can include the steps of collecting a sample of cells from a subject, isolating nucleic acid (e.g., genomic, mRNA or both) from the sample, contacting the nucleic acid sample with one or more primers which specifically hybridize to a 47508 gene under

conditions such that hybridization and amplification of the 47508-gene (if present) occurs, and detecting the presence or absence of an amplification product, or detecting the size of the amplification product and comparing the length to a control sample. It is anticipated that PCR and/or LCR may be desirable to use as a preliminary amplification step in conjunction with any of the techniques used for detecting mutations described herein. Alternatively, other amplification methods described herein or known in the art can be used.

In another embodiment, mutations in a 47508 gene from a sample cell can be identified by detecting alterations in restriction enzyme cleavage patterns. For example, sample and control DNA is isolated, amplified (optionally), digested with one or more restriction endonucleases, and fragment length sizes are determined, e.g., by gel electrophoresis and compared. Differences in fragment length sizes between sample and control DNA indicates mutations in the sample DNA. Moreover, the use of sequence specific ribozymes (see, for example, U.S. Patent No. 5,498,531) can be used to score for the presence of specific mutations by development or loss of a ribozyme cleavage site.

In other embodiments, genetic mutations in 47508 can be identified by hybridizing a sample and control nucleic acids, e.g., DNA or RNA, two-dimensional arrays, e.g., chip based arrays. Such arrays include a plurality of addresses, each of which is positionally distinguishable from the other. A different probe is located at each address of the plurality. A probe can be complementary to a region of a 47508 nucleic acid or a putative variant (e.g., allelic variant) thereof. A probe can have one or more mismatches to a region of a 47508 nucleic acid (e.g., a destabilizing mismatch). The arrays can have a high density of addresses, e.g., can contain hundreds or thousands of oligonucleotides probes (Cronin, M.T. *et al.* (1996) *Human Mutation* 7: 244-255; Kozal, M.J. *et al.* (1996) *Nature Medicine* 2: 753-759). For example, genetic mutations in 47508 can be identified in two-dimensional arrays containing light-generated DNA probes as described in Cronin, M.T. *et al. supra*. Briefly, a first hybridization array of probes can be used to scan through long stretches of DNA in a sample and control to identify base changes between the sequences by making linear arrays of sequential overlapping probes. This step allows the identification of point mutations. This step is followed by a second hybridization array that allows the characterization of specific mutations by using smaller, specialized probe arrays complementary to all variants or mutations detected. Each mutation array is composed of parallel probe sets, one complementary to the wild-type gene and the other complementary to the mutant gene.

In yet another embodiment, any of a variety of sequencing reactions known in the art can be used to directly sequence the 47508 gene and detect mutations by comparing the sequence of the sample 47508 with the corresponding wild-type (control) sequence.

Automated sequencing procedures can be utilized when performing the diagnostic assays 5 ((1995) *Biotechniques* 19:448), including sequencing by mass spectrometry.

Other methods for detecting mutations in the 47508 gene include methods in which protection from cleavage agents is used to detect mismatched bases in RNA/RNA or RNA/DNA heteroduplexes (Myers *et al.* (1985) *Science* 230:1242; Cotton *et al.* (1988) *Proc. Natl Acad Sci USA* 85:4397; Saleeba *et al.* (1992) *Methods Enzymol.* 217:286-295).

10 In still another embodiment, the mismatch cleavage reaction employs one or more proteins that recognize mismatched base pairs in double-stranded DNA (so called "DNA mismatch repair" enzymes) in defined systems for detecting and mapping point mutations in 47508 cDNAs obtained from samples of cells. For example, the mutY enzyme of *E. coli* cleaves A at G/A mismatches and the thymidine DNA glycosylase from HeLa cells cleaves 15 T at G/T mismatches (Hsu *et al.* (1994) *Carcinogenesis* 15:1657-1662; U.S. Patent No. 5,459,039).

In other embodiments, alterations in electrophoretic mobility will be used to identify 20 mutations in 47508 genes. For example, single strand conformation polymorphism (SSCP) may be used to detect differences in electrophoretic mobility between mutant and wild type nucleic acids (Orita *et al.* (1989) *Proc Natl. Acad. Sci USA*: 86:2766, see also Cotton (1993) *Mutat. Res.* 285:125-144; and Hayashi (1992) *Genet. Anal. Tech. Appl.* 9:73-79). Single-stranded DNA fragments of sample and control 47508 nucleic acids will be denatured and allowed to renature. The secondary structure of single-stranded nucleic acids varies according to sequence, the resulting alteration in electrophoretic mobility enables the 25 detection of even a single base change. The DNA fragments may be labeled or detected with labeled probes. The sensitivity of the assay may be enhanced by using RNA (rather than DNA), in which the secondary structure is more sensitive to a change in sequence. In a preferred embodiment, the subject method utilizes heteroduplex analysis to separate double stranded heteroduplex molecules on the basis of changes in electrophoretic mobility (Keen 30 *et al.* (1991) *Trends Genet* 7:5).

In yet another embodiment, the movement of mutant or wild-type fragments in polyacrylamide gels containing a gradient of denaturant is assayed using denaturing gradient gel electrophoresis (DGGE) (Myers *et al.* (1985) *Nature* 313:495). When DGGE is used as

the method of analysis, DNA will be modified to insure that it does not completely denature, for example by adding a GC clamp of approximately 40 bp of high-melting GC-rich DNA by PCR. In a further embodiment, a temperature gradient is used in place of a denaturing gradient to identify differences in the mobility of control and sample DNA (Rosenbaum and 5 Reissner (1987) *Biophys Chem* 265:12753).

Examples of other techniques for detecting point mutations include, but are not limited to, selective oligonucleotide hybridization, selective amplification, or selective primer extension (Saiki *et al.* (1986) *Nature* 324:163); Saiki *et al.* (1989) *Proc. Natl Acad. Sci USA* 86:6230). A further method of detecting point mutations is the chemical ligation of 10 oligonucleotides as described in Xu *et al.* ((2001) *Nature Biotechnol.* 19:148). Adjacent oligonucleotides, one of which selectively anneals to the query site, are ligated together if the nucleotide at the query site of the sample nucleic acid is complementary to the query oligonucleotide; ligation can be monitored, e.g., by fluorescent dyes coupled to the oligonucleotides.

15 Alternatively, allele specific amplification technology that depends on selective PCR amplification may be used in conjunction with the instant invention. Oligonucleotides used as primers for specific amplification may carry the mutation of interest in the center of the molecule (so that amplification depends on differential hybridization) (Gibbs *et al.* (1989) *Nucleic Acids Res.* 17:2437-2448) or at the extreme 3' end of one primer where, under 20 appropriate conditions, mismatch can prevent, or reduce polymerase extension (Prossner (1993) *Tibtech* 11:238). In addition it may be desirable to introduce a novel restriction site in the region of the mutation to create cleavage-based detection (Gasparini *et al.* (1992) *Mol. Cell Probes* 6:1). It is anticipated that in certain embodiments amplification may also be performed using Taq ligase for amplification (Barany (1991) *Proc. Natl. Acad. Sci USA* 25 88:189). In such cases, ligation will occur only if there is a perfect match at the 3' end of the 5' sequence making it possible to detect the presence of a known mutation at a specific site by looking for the presence or absence of amplification.

30 In another aspect, the invention features a set of oligonucleotides. The set includes a plurality of oligonucleotides, each of which is at least partially complementary (e.g., at least 50%, 60%, 70%, 80%, 90%, 92%, 95%, 97%, 98%, or 99% complementary) to a 47508 nucleic acid.

In a preferred embodiment the set includes a first and a second oligonucleotide. The first and second oligonucleotide can hybridize to the same or to different locations of SEQ

ID NO:1 or the complement of SEQ ID NO:1. Different locations can be different but overlapping, or non-overlapping on the same strand. The first and second oligonucleotide can hybridize to sites on the same or on different strands.

The set can be useful, e.g., for identifying SNP's, or identifying specific alleles of 5 47508. In a preferred embodiment, each oligonucleotide of the set has a different nucleotide at an interrogation position. In one embodiment, the set includes two oligonucleotides, each complementary to a different allele at a locus, e.g., a biallelic or polymorphic locus.

In another embodiment, the set includes four oligonucleotides, each having a 10 different nucleotide (e.g., adenine, guanine, cytosine, or thymidine) at the interrogation position. The interrogation position can be a SNP or the site of a mutation. In another preferred embodiment, the oligonucleotides of the plurality are identical in sequence to one another (except for differences in length). The oligonucleotides can be provided with differential labels, such that an oligonucleotide that hybridizes to one allele provides a signal 15 that is distinguishable from an oligonucleotide that hybridizes to a second allele. In still another embodiment, at least one of the oligonucleotides of the set has a nucleotide change at a position in addition to a query position, e.g., a destabilizing mutation to decrease the T_m of the oligonucleotide. In another embodiment, at least one oligonucleotide of the set has a 20 non-natural nucleotide, e.g., inosine. In a preferred embodiment, the oligonucleotides are attached to a solid support, e.g., to different addresses of an array or to different beads or nanoparticles.

In a preferred embodiment the set of oligo nucleotides can be used to specifically amplify, e.g., by PCR, or detect, a 47508 nucleic acid.

The methods described herein may be performed, for example, by utilizing pre-packaged diagnostic kits comprising at least one probe nucleic acid or antibody reagent 25 described herein, which may be conveniently used, e.g., in clinical settings to diagnose patients exhibiting symptoms or family history of a disease or illness involving a 47508 gene.

Use of 47508 Molecules as Surrogate Markers

The 47508 molecules of the invention are also useful as markers of disorders or 30 disease states, as markers for precursors of disease states, as markers for predisposition of disease states, as markers of drug activity, or as markers of the pharmacogenomic profile of a subject. Using the methods described herein, the presence, absence and/or quantity of the

47508 molecules of the invention may be detected, and may be correlated with one or more biological states in vivo. For example, the 47508 molecules of the invention may serve as surrogate markers for one or more disorders or disease states or for conditions leading up to disease states. As used herein, a "surrogate marker" is an objective biochemical marker which correlates with the absence or presence of a disease or disorder, or with the progression of a disease or disorder (e.g., with the presence or absence of a tumor). The presence or quantity of such markers is independent of the disease. Therefore, these markers may serve to indicate whether a particular course of treatment is effective in lessening a disease state or disorder. Surrogate markers are of particular use when the presence or extent of a disease state or disorder is difficult to assess through standard methodologies (e.g., early stage tumors), or when an assessment of disease progression is desired before a potentially dangerous clinical endpoint is reached (e.g., an assessment of cardiovascular disease may be made using cholesterol levels as a surrogate marker, and an analysis of HIV infection may be made using HIV RNA levels as a surrogate marker, well in advance of the undesirable clinical outcomes of myocardial infarction or fully-developed AIDS). Examples of the use of surrogate markers in the art include: Koomen *et al.* (2000) *J. Mass. Spectrom.* 35: 258-264; and James (1994) *AIDS Treatment News Archive* 209.

The 47508 molecules of the invention are also useful as pharmacodynamic markers. As used herein, a "pharmacodynamic marker" is an objective biochemical marker which correlates specifically with drug effects. The presence or quantity of a pharmacodynamic marker is not related to the disease state or disorder for which the drug is being administered; therefore, the presence or quantity of the marker is indicative of the presence or activity of the drug in a subject. For example, a pharmacodynamic marker may be indicative of the concentration of the drug in a biological tissue, in that the marker is either expressed or transcribed or not expressed or transcribed in that tissue in relationship to the level of the drug. In this fashion, the distribution or uptake of the drug may be monitored by the pharmacodynamic marker. Similarly, the presence or quantity of the pharmacodynamic marker may be related to the presence or quantity of the metabolic product of a drug, such that the presence or quantity of the marker is indicative of the relative breakdown rate of the drug in vivo. Pharmacodynamic markers are of particular use in increasing the sensitivity of detection of drug effects, particularly when the drug is administered in low doses. Since even a small amount of a drug may be sufficient to activate multiple rounds of marker (e.g., a 47508 marker) transcription or expression, the amplified marker may be in a quantity

which is more readily detectable than the drug itself. Also, the marker may be more easily detected due to the nature of the marker itself; for example, using the methods described herein, anti-47508 antibodies may be employed in an immune-based detection system for a 47508 protein marker, or 47508-specific radiolabeled probes may be used to detect a 47508 mRNA marker. Furthermore, the use of a pharmacodynamic marker may offer mechanism-based prediction of risk due to drug treatment beyond the range of possible direct observations. Examples of the use of pharmacodynamic markers in the art include: Matsuda *et al.* US 6,033,862; Hattis *et al.* (1991) *Env. Health Perspect.* 90: 229-238; Schentag (1999) *Am. J. Health-Syst. Pharm.* 56 Suppl. 3: S21-S24; and Nicolau (1999) *Am. J. Health-Syst. Pharm.* 56 Suppl. 3: S16-S20.

The 47508 molecules of the invention are also useful as pharmacogenomic markers. As used herein, a "pharmacogenomic marker" is an objective biochemical marker which correlates with a specific clinical drug response or susceptibility in a subject (see, e.g., McLeod *et al.* (1999) *Eur. J. Cancer* 35:1650-1652). The presence or quantity of the pharmacogenomic marker is related to the predicted response of the subject to a specific drug or class of drugs prior to administration of the drug. By assessing the presence or quantity of one or more pharmacogenomic markers in a subject, a drug therapy which is most appropriate for the subject, or which is predicted to have a greater degree of success, may be selected. For example, based on the presence or quantity of RNA, or protein (e.g., 47508 protein or RNA) for specific tumor markers in a subject, a drug or course of treatment may be selected that is optimized for the treatment of the specific tumor likely to be present in the subject. Similarly, the presence or absence of a specific sequence mutation in 47508 DNA may correlate 47508 drug response. The use of pharmacogenomic markers therefore permits the application of the most appropriate treatment for each subject without having to administer the therapy.

Pharmaceutical Compositions

The nucleic acid and polypeptides, fragments thereof, as well as anti-47508 antibodies (also referred to herein as "active compounds") of the invention can be incorporated into pharmaceutical compositions. Such compositions typically include the nucleic acid molecule, protein, or antibody and a pharmaceutically acceptable carrier. As used herein the language "pharmaceutically acceptable carrier" includes solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption delaying agents,

and the like, compatible with pharmaceutical administration. Supplementary active compounds can also be incorporated into the compositions.

A pharmaceutical composition is formulated to be compatible with its intended route of administration. Examples of routes of administration include parenteral, e.g., 5 intravenous, intradermal, subcutaneous, oral (e.g., inhalation), transdermal (topical), transmucosal, and rectal administration. Solutions or suspensions used for parenteral, intradermal, or subcutaneous application can include the following components: a sterile diluent such as water for injection, saline solution, fixed oils, polyethylene glycols, glycerine, propylene glycol or other synthetic solvents; antibacterial agents such as benzyl 10 alcohol or methyl parabens; antioxidants such as ascorbic acid or sodium bisulfite; chelating agents such as ethylenediaminetetraacetic acid; buffers such as acetates, citrates or phosphates and agents for the adjustment of tonicity such as sodium chloride or dextrose. pH can be adjusted with acids or bases, such as hydrochloric acid or sodium hydroxide. The parenteral preparation can be enclosed in ampoules, disposable syringes or multiple dose 15 vials made of glass or plastic.

Pharmaceutical compositions suitable for injectable use include sterile aqueous solutions (where water soluble) or dispersions and sterile powders for the extemporaneous preparation of sterile injectable solutions or dispersion. For intravenous administration, suitable carriers include physiological saline, bacteriostatic water, Cremophor EL™ (BASF, 20 Parsippany, NJ) or phosphate buffered saline (PBS). In all cases, the composition must be sterile and should be fluid to the extent that easy syringability exists. It should be stable under the conditions of manufacture and storage and must be preserved against the contaminating action of microorganisms such as bacteria and fungi. The carrier can be a solvent or dispersion medium containing, for example, water, ethanol, polyol (for example, 25 glycerol, propylene glycol, and liquid polyethyleneglycol, and the like), and suitable mixtures thereof. The proper fluidity can be maintained, for example, by the use of a coating such as lecithin, by the maintenance of the required particle size in the case of dispersion and by the use of surfactants. Prevention of the action of microorganisms can be achieved by various antibacterial and antifungal agents, for example, parabens, 30 chlorobutanol, phenol, ascorbic acid, thimerosal, and the like. In many cases, it will be preferable to include isotonic agents, for example, sugars, polyalcohols such as manitol, sorbitol, sodium chloride in the composition. Prolonged absorption of the injectable

compositions can be brought about by including in the composition an agent which delays absorption, for example, aluminum monostearate and gelatin.

Sterile injectable solutions can be prepared by incorporating the active compound in the required amount in an appropriate solvent with one or a combination of ingredients 5 enumerated above, as required, followed by filtered sterilization. Generally, dispersions are prepared by incorporating the active compound into a sterile vehicle which contains a basic dispersion medium and the required other ingredients from those enumerated above. In the case of sterile powders for the preparation of sterile injectable solutions, the preferred methods of preparation are vacuum drying and freeze-drying which yields a powder of the 10 active ingredient plus any additional desired ingredient from a previously sterile-filtered solution thereof.

Oral compositions generally include an inert diluent or an edible carrier. For the purpose of oral therapeutic administration, the active compound can be incorporated with excipients and used in the form of tablets, troches, or capsules, e.g., gelatin capsules. Oral 15 compositions can also be prepared using a fluid carrier for use as a mouthwash.

Pharmaceutically compatible binding agents, and/or adjuvant materials can be included as part of the composition. The tablets, pills, capsules, troches and the like can contain any of the following ingredients, or compounds of a similar nature: a binder such as microcrystalline cellulose, gum tragacanth or gelatin; an excipient such as starch or lactose, 20 a disintegrating agent such as alginic acid, Primogel, or corn starch; a lubricant such as magnesium stearate or Sterotes; a glidant such as colloidal silicon dioxide; a sweetening agent such as sucrose or saccharin; or a flavoring agent such as peppermint, methyl salicylate, or orange flavoring.

For administration by inhalation, the compounds are delivered in the form of an 25 aerosol spray from pressured container or dispenser which contains a suitable propellant, e.g., a gas such as carbon dioxide, or a nebulizer.

Systemic administration can also be by transmucosal or transdermal means. For transmucosal or transdermal administration, penetrants appropriate to the barrier to be permeated are used in the formulation. Such penetrants are generally known in the art, and 30 include, for example, for transmucosal administration, detergents, bile salts, and fusidic acid derivatives. Transmucosal administration can be accomplished through the use of nasal sprays or suppositories. For transdermal administration, the active compounds are formulated into ointments, salves, gels, or creams as generally known in the art.

The compounds can also be prepared in the form of suppositories (e.g., with conventional suppository bases such as cocoa butter and other glycerides) or retention enemas for rectal delivery.

In one embodiment, the active compounds are prepared with carriers that will protect the compound against rapid elimination from the body, such as a controlled release formulation, including implants and microencapsulated delivery systems. Biodegradable, biocompatible polymers can be used, such as ethylene vinyl acetate, polyanhydrides, polyglycolic acid, collagen, polyorthoesters, and polylactic acid. Methods for preparation of such formulations will be apparent to those skilled in the art. The materials can also be obtained commercially from Alza Corporation and Nova Pharmaceuticals, Inc. Liposomal suspensions (including liposomes targeted to infected cells with monoclonal antibodies to viral antigens) can also be used as pharmaceutically acceptable carriers. These can be prepared according to methods known to those skilled in the art, for example, as described in U.S. Patent No. 4,522,811.

It is advantageous to formulate oral or parenteral compositions in dosage unit form for ease of administration and uniformity of dosage. Dosage unit form as used herein refers to physically discrete units suited as unitary dosages for the subject to be treated; each unit containing a predetermined quantity of active compound calculated to produce the desired therapeutic effect in association with the required pharmaceutical carrier.

Toxicity and therapeutic efficacy of such compounds can be determined by standard pharmaceutical procedures in cell cultures or experimental animals, e.g., for determining the LD50 (the dose lethal to 50% of the population) and the ED50 (the dose therapeutically effective in 50% of the population). The dose ratio between toxic and therapeutic effects is the therapeutic index and it can be expressed as the ratio LD50/ED50. Compounds which exhibit high therapeutic indices are preferred. While compounds that exhibit toxic side effects may be used, care should be taken to design a delivery system that targets such compounds to the site of affected tissue in order to minimize potential damage to uninfected cells and, thereby, reduce side effects.

The data obtained from the cell culture assays and animal studies can be used in formulating a range of dosage for use in humans. The dosage of such compounds lies preferably within a range of circulating concentrations that include the ED50 with little or no toxicity. The dosage may vary within this range depending upon the dosage form employed and the route of administration utilized. For any compound used in the method of

the invention, the therapeutically effective dose can be estimated initially from cell culture assays. A dose may be formulated in animal models to achieve a circulating plasma concentration range that includes the IC₅₀ (i.e., the concentration of the test compound which achieves a half-maximal inhibition of symptoms) as determined in cell culture. Such 5 information can be used to more accurately determine useful doses in humans. Levels in plasma may be measured, for example, by high performance liquid chromatography.

As defined herein, a therapeutically effective amount of protein or polypeptide (i.e., an effective dosage) ranges from about 0.001 to 30 mg/kg body weight, preferably about 0.01 to 25 mg/kg body weight, more preferably about 0.1 to 20 mg/kg body weight, and 10 even more preferably about 1 to 10 mg/kg, 2 to 9 mg/kg, 3 to 8 mg/kg, 4 to 7 mg/kg, or 5 to 6 mg/kg body weight. The protein or polypeptide can be administered one time per week for between about 1 to 10 weeks, preferably between 2 to 8 weeks, more preferably between about 3 to 7 weeks, and even more preferably for about 4, 5, or 6 weeks. The skilled artisan will appreciate that certain factors may influence the dosage and timing required to 15 effectively treat a subject, including but not limited to the severity of the disease or disorder, previous treatments, the general health and/or age of the subject, and other diseases present. Moreover, treatment of a subject with a therapeutically effective amount of a protein, polypeptide, or antibody can include a single treatment or, preferably, can include a series of treatments.

20 For antibodies, the preferred dosage is 0.1 mg/kg of body weight (generally 10 mg/kg to 20 mg/kg). If the antibody is to act in the brain, a dosage of 50 mg/kg to 100 mg/kg is usually appropriate. Generally, partially human antibodies and fully human antibodies have a longer half-life within the human body than other antibodies. Accordingly, lower dosages and less frequent administration is often possible.

25 Modifications such as lipidation can be used to stabilize antibodies and to enhance uptake and tissue penetration (e.g., into the brain). A method for lipidation of antibodies is described by Cruikshank *et al.* ((1997) *J. Acquired Immune Deficiency Syndromes and Human Retrovirology* 14:193).

The present invention encompasses agents which modulate expression or activity. 30 An agent may, for example, be a small molecule. For example, such small molecules include, but are not limited to, peptides, peptidomimetics (e.g., peptoids), amino acids, amino acid analogs, polynucleotides, polynucleotide analogs, nucleotides, nucleotide analogs, organic or inorganic compounds (i.e., including heteroorganic and organometallic

compounds) having a molecular weight less than about 10,000 grams per mole, organic or inorganic compounds having a molecular weight less than about 5,000 grams per mole, organic or inorganic compounds having a molecular weight less than about 1,000 grams per mole, organic or inorganic compounds having a molecular weight less than about 500 grams per mole, and salts, esters, and other pharmaceutically acceptable forms of such compounds.

Exemplary doses include milligram or microgram amounts of the small molecule per kilogram of subject or sample weight (e.g., about 1 microgram per kilogram to about 500 milligrams per kilogram, about 100 micrograms per kilogram to about 5 milligrams per kilogram, or about 1 microgram per kilogram to about 50 micrograms per kilogram. It is 5 furthermore understood that appropriate doses of a small molecule depend upon the potency of the small molecule with respect to the expression or activity to be modulated. When one or more of these small molecules is to be administered to an animal (e.g., a human) in order to modulate expression or activity of a polypeptide or nucleic acid of the invention, a physician, veterinarian, or researcher may, for example, prescribe a relatively low dose at 10 first, subsequently increasing the dose until an appropriate response is obtained. In addition, it is understood that the specific dose level for any particular animal subject will depend 15 upon a variety of factors including the activity of the specific compound employed, the age, body weight, general health, gender, and diet of the subject, the time of administration, the route of administration, the rate of excretion, any drug combination, and the degree of expression or activity to be modulated.

An antibody (or fragment thereof) may be conjugated to a therapeutic moiety such as a cytotoxin, a therapeutic agent or a radioactive ion. A cytotoxin or cytotoxic agent includes any agent that is detrimental to cells. Examples include taxol, cytochalasin B, gramicidin D, ethidium bromide, emetine, mitomycin, etoposide, tenoposide, vincristine, vinblastine, 25 colchicine, doxorubicin, daunorubicin, dihydroxy anthracin dione, mitoxantrone, mithramycin, actinomycin D, 1-dehydrotestosterone, glucocorticoids, procaine, tetracaine, lidocaine, propranolol, puromycin, maytansinoids, e.g., maytansinol (see US Patent No. 5,208,020), CC-1065 (see US Patent Nos. 5,475,092, 5,585,499, 5,846,545) and analogs or homologs thereof. Therapeutic agents include, but are not limited to, antimetabolites (e.g., 30 methotrexate, 6-mercaptopurine, 6-thioguanine, cytarabine, 5-fluorouracil decarbazine), alkylating agents (e.g., mechlorethamine, thioepa chlorambucil, CC-1065, melphalan, carmustine (BSNU) and lomustine (CCNU), cyclophosphamide, busulfan, dibromomannitol, streptozotocin, mitomycin C, and cis-dichlorodiamine platinum (II) (DDP) cisplatin),

anthracyclines (e.g., daunorubicin (formerly daunomycin) and doxorubicin), antibiotics (e.g., dactinomycin (formerly actinomycin), bleomycin, mithramycin, and anthramycin (AMC)), and anti-mitotic agents (e.g., vincristine, vinblastine, taxol and maytansinoids). Radioactive ions include, but are not limited to iodine, yttrium and praseodymium.

5 The conjugates of the invention can be used for modifying a given biological response, the drug moiety is not to be construed as limited to classical chemical therapeutic agents. For example, the drug moiety may be a protein or polypeptide possessing a desired biological activity. Such proteins may include, for example, a toxin such as abrin, ricin A, pseudomonas exotoxin, or diphtheria toxin; a protein such as tumor necrosis factor, α -interferon, β -interferon, nerve growth factor, platelet derived growth factor, tissue plasminogen activator; or, biological response modifiers such as, for example, lymphokines, interleukin-1 ("IL-1"), interleukin-2 ("IL-2"), interleukin-6 ("IL-6"), granulocyte macrophage colony stimulating factor ("GM-CSF"), granulocyte colony stimulating factor ("G-CSF"), or other growth factors.

10 15 Alternatively, an antibody can be conjugated to a second antibody to form an antibody heteroconjugate as described by Segal in U.S. Patent No. 4,676,980.

The nucleic acid molecules of the invention can be inserted into vectors and used as gene therapy vectors. Gene therapy vectors can be delivered to a subject by, for example, intravenous injection, local administration (see U.S. Patent 5,328,470) or by stereotactic injection (see e.g., Chen *et al.* (1994) *Proc. Natl. Acad. Sci. USA* 91:3054-3057). The pharmaceutical preparation of the gene therapy vector can include the gene therapy vector in an acceptable diluent, or can comprise a slow release matrix in which the gene delivery vehicle is imbedded. Alternatively, where the complete gene delivery vector can be produced intact from recombinant cells, e.g., retroviral vectors, the pharmaceutical preparation can include one or more cells which produce the gene delivery system.

The pharmaceutical compositions can be included in a container, pack, or dispenser together with instructions for administration.

Methods of Treatment

The present invention provides for both prophylactic and therapeutic methods of treating a subject at risk of (or susceptible to) a disorder or having a disorder associated with aberrant or unwanted 47508 expression or activity. As used herein, the term "treatment" is defined as the application or administration of a therapeutic agent to a patient, or application

or administration of a therapeutic agent to an isolated tissue or cell line from a patient, who has a disease, a symptom of disease or a predisposition toward a disease, with the purpose to cure, heal, alleviate, relieve, alter, remedy, ameliorate, improve or affect the disease, the symptoms of disease or the predisposition toward disease. A therapeutic agent includes, but 5 is not limited to, small molecules, peptides, antibodies, ribozymes and antisense oligonucleotides.

With regards to both prophylactic and therapeutic methods of treatment, such treatments may be specifically tailored or modified, based on knowledge obtained from the field of pharmacogenomics. "Pharmacogenomics", as used herein, refers to the application 10 of genomics technologies such as gene sequencing, statistical genetics, and gene expression analysis to drugs in clinical development and on the market. More specifically, the term refers the study of how a patient's genes determine his or her response to a drug (e.g., a patient's "drug response phenotype", or "drug response genotype".) Thus, another aspect of the invention provides methods for tailoring an individual's prophylactic or therapeutic 15 treatment with either the 47508 molecules of the present invention or 47508 modulators according to that individual's drug response genotype. Pharmacogenomics allows a clinician or physician to target prophylactic or therapeutic treatments to patients who will most benefit from the treatment and to avoid treatment of patients who will experience toxic drug-related side effects.

20 In one aspect, the invention provides a method for preventing in a subject, a disease or condition associated with an aberrant or unwanted 47508 expression or activity, by administering to the subject a 47508 or an agent which modulates 47508 expression or at least one 47508 activity. Subjects at risk for a disease which is caused or contributed to by 25 aberrant or unwanted 47508 expression or activity can be identified by, for example, any or a combination of diagnostic or prognostic assays as described herein. Administration of a prophylactic agent can occur prior to the manifestation of symptoms characteristic of the 47508 aberrance, such that a disease or disorder is prevented or, alternatively, delayed in its progression. Depending on the type of 47508 aberrance, for example, a 47508, 47508 agonist or 47508 antagonist agent can be used for treating the subject. The appropriate 30 agent can be determined based on screening assays described herein.

It is possible that some 47508 disorders can be caused, at least in part, by an abnormal level of gene product, or by the presence of a gene product exhibiting abnormal

activity. As such, the reduction in the level and/or activity of such gene products would bring about the amelioration of disorder symptoms.

The 47508 molecules can act as novel diagnostic targets and therapeutic agents for controlling one or more of cellular proliferative and/or differentiative disorders, disorders of the breast, ovary, lung, colon, and liver, as well cardiovascular disorders, as has been described above. In addition, the 47508 molecules of the invention can act as novel diagnostic targets and therapeutic agents for controlling disorders associated with bone metabolism, immune disorders, viral diseases, and pain or metabolic disorders.

Aberrant expression and/or activity of 47508 molecules may mediate disorders associated with bone metabolism. "Bone metabolism" refers to direct or indirect effects in the formation or degeneration of bone structures, e.g., bone formation, bone resorption, etc., which may ultimately affect the concentrations in serum of calcium and phosphate. This term also includes activities mediated by 47508 molecules effects in bone cells, e.g. osteoclasts and osteoblasts, that may in turn result in bone formation and degeneration. For example, 47508 molecules may support different activities of bone resorbing osteoclasts such as the stimulation of differentiation of monocytes and mononuclear phagocytes into osteoclasts. Accordingly, 47508 molecules that modulate the production of bone cells can influence bone formation and degeneration, and thus may be used to treat bone disorders. Examples of such disorders include, but are not limited to, osteoporosis, osteodystrophy, osteomalacia, rickets, osteitis fibrosa cystica, renal osteodystrophy, osteosclerosis, anti-convulsant treatment, osteopenia, fibrogenesis-imperfecta ossium, secondary hyperparathyroidism, hypoparathyroidism, hyperparathyroidism, cirrhosis, obstructive jaundice, drug induced metabolism, medullary carcinoma, chronic renal disease, rickets, sarcoidosis, glucocorticoid antagonism, malabsorption syndrome, steatorrhea, tropical sprue, idiopathic hypercalcemia and milk fever.

The 47508 nucleic acid and protein of the invention can be used to treat and/or diagnose a variety of immune disorders. Examples of immune disorders or diseases include, but are not limited to, autoimmune diseases (including, for example, diabetes mellitus, arthritis (including rheumatoid arthritis, juvenile rheumatoid arthritis, osteoarthritis, psoriatic arthritis), multiple sclerosis, encephalomyelitis, myasthenia gravis, systemic lupus erythematosus, autoimmune thyroiditis, dermatitis (including atopic dermatitis and eczematous dermatitis), psoriasis, Sjögren's Syndrome, Crohn's disease, aphthous ulcer, iritis, conjunctivitis, keratoconjunctivitis, ulcerative colitis, asthma, allergic asthma,

cutaneous lupus erythematosus, scleroderma, vaginitis, proctitis, drug eruptions, leprosy reversal reactions, erythema nodosum leprosum, autoimmune uveitis, allergic encephalomyelitis, acute necrotizing hemorrhagic encephalopathy, idiopathic bilateral progressive sensorineural hearing loss, aplastic anemia, pure red cell anemia, idiopathic 5 thrombocytopenia, polychondritis, Wegener's granulomatosis, chronic active hepatitis, Stevens-Johnson syndrome, idiopathic sprue, lichen planus, Graves' disease, sarcoidosis, primary biliary cirrhosis, uveitis posterior, and interstitial lung fibrosis), graft-versus-host disease, cases of transplantation, and allergy such as, atopic allergy.

Additionally, 47508 molecules may play an important role in the etiology of certain 10 viral diseases, including but not limited to Hepatitis B, Hepatitis C and Herpes Simplex Virus (HSV). Modulators of 47508 activity could be used to control viral diseases. The modulators can be used in the treatment and/or diagnosis of viral infected tissue or virus-associated tissue fibrosis, especially liver and liver fibrosis. Also, 47508 modulators can be used in the treatment and/or diagnosis of virus-associated carcinoma, especially 15 hepatocellular cancer.

Additionally, 47508 may play an important role in the regulation of metabolism or pain disorders. Diseases of metabolic imbalance include, but are not limited to, obesity, 20 anorexia nervosa, cachexia, lipid disorders, and diabetes. Examples of pain disorders include, but are not limited to, pain response elicited during various forms of tissue injury, e.g., inflammation, infection, and ischemia, usually referred to as hyperalgesia (described in, for example, Fields, H.L. (1987) *Pain*, New York:McGraw-Hill); pain associated with musculoskeletal disorders, e.g., joint pain; tooth pain; headaches; pain associated with surgery; pain related to irritable bowel syndrome; or chest pain.

Additional disorders which may be treated or diagnosed by methods described herein 25 include, but are not limited to, disorders associated with an accumulation in the liver of fibrous tissue, such as that resulting from an imbalance between production and degradation of the extracellular matrix accompanied by the collapse and condensation of preexisting fibers. The methods described herein can be used to diagnose or treat hepatocellular necrosis or injury induced by a wide variety of agents including processes which disturb 30 homeostasis, such as an inflammatory process, tissue damage resulting from toxic injury or altered hepatic blood flow, and infections (e.g., bacterial, viral and parasitic). For example, the methods can be used for the early detection of hepatic injury, such as portal hypertension or hepatic fibrosis. In addition, the methods can be employed to detect liver fibrosis

attributed to inborn errors of metabolism, for example, fibrosis resulting from a storage disorder such as Gaucher's disease (lipid abnormalities) or a glycogen storage disease, A1-antitrypsin deficiency; a disorder mediating the accumulation (e.g., storage) of an exogenous substance, for example, hemochromatosis (iron-overload syndrome) and copper storage diseases (Wilson's disease), disorders resulting in the accumulation of a toxic metabolite (e.g., tyrosinemia, fructosemia and galactosemia) and peroxisomal disorders (e.g., Zellweger syndrome). Additionally, the methods described herein may be useful for the early detection and treatment of liver injury associated with the administration of various chemicals or drugs, such as for example, methotrexate, isonizaid, oxyphenisatin,

5 10 methyldopa, chlorpromazine, tolbutamide or alcohol, or which represents a hepatic manifestation of a vascular disorder such as obstruction of either the intrahepatic or extrahepatic bile flow or an alteration in hepatic circulation resulting, for example, from chronic heart failure, veno-occlusive disease, portal vein thrombosis or Budd-Chiari syndrome.

15 As used herein, disorders involving the heart, or "cardiovascular disease" or a "cardiovascular disorder" includes a disease or disorder which affects the cardiovascular system, e.g., the heart, the blood vessels, and/or the blood. A cardiovascular disorder can be caused by an imbalance in arterial pressure, a malfunction of the heart, or an occlusion of a blood vessel, e.g., by a thrombus. A cardiovascular disorder includes, but is not limited to

20 disorders such as arteriosclerosis, atherosclerosis, cardiac hypertrophy, ischemia reperfusion injury, restenosis, arterial inflammation, vascular wall remodeling, ventricular remodeling, rapid ventricular pacing, coronary microembolism, tachycardia, bradycardia, pressure overload, aortic bending, coronary artery ligation, vascular heart disease, valvular disease, including but not limited to, valvular degeneration caused by calcification, rheumatic heart

25 disease, endocarditis, or complications of artificial valves; atrial fibrillation, long-QT syndrome, congestive heart failure, sinus node dysfunction, angina, heart failure, hypertension, atrial fibrillation, atrial flutter, pericardial disease, including but not limited to, pericardial effusion and pericarditis; cardiomyopathies, e.g., dilated cardiomyopathy or idiopathic cardiomyopathy, myocardial infarction, coronary artery disease, coronary artery

30 spasm, ischemic disease, arrhythmia, sudden cardiac death, and cardiovascular developmental disorders (e.g., arteriovenous malformations, arteriovenous fistulae, raynaud's syndrome, neurogenic thoracic outlet syndrome, causalgia/reflex sympathetic dystrophy, hemangioma, aneurysm, cavernous angioma, aortic valve stenosis, atrial septal

defects, atrioventricular canal, coarctation of the aorta, ebsteins anomaly, hypoplastic left heart syndrome, interruption of the aortic arch, mitral valve prolapse, ductus arteriosus, patent foramen ovale, partial anomalous pulmonary venous return, pulmonary atresia with ventricular septal defect, pulmonary atresia without ventricular septal defect, persistance of 5 the fetal circulation, pulmonary valve stenosis, single ventricle, total anomalous pulmonary venous return, transposition of the great vessels, tricuspid atresia, truncus arteriosus, ventricular septal defects). A cardiovascular disease or disorder also can include an endothelial cell disorder.

As used herein, an "endothelial cell disorder" includes a disorder characterized by 10 aberrant, unregulated, or unwanted endothelial cell activity, e.g., proliferation, migration, angiogenesis, or vascularization; or aberrant expression of cell surface adhesion molecules or genes associated with angiogenesis, e.g., TIE-2, FLT and FLK. Endothelial cell disorders include tumorigenesis, tumor metastasis, psoriasis, diabetic retinopathy, endometriosis, Grave's disease, ischemic disease (e.g., atherosclerosis), and chronic inflammatory diseases 15 (e.g., rheumatoid arthritis).

As discussed, successful treatment of 47508 disorders can be brought about by techniques that serve to inhibit the expression or activity of target gene products. For example, compounds, e.g., an agent identified using an assays described above, that proves to exhibit negative modulatory activity, can be used in accordance with the invention to 20 prevent and/or ameliorate symptoms of 47508 disorders. Such molecules can include, but are not limited to peptides, phosphopeptides, small organic or inorganic molecules, or antibodies (including, for example, polyclonal, monoclonal, humanized, anti-idiotypic, chimeric or single chain antibodies, and Fab, F(ab')₂ and Fab expression library fragments, scFV molecules, and epitope-binding fragments thereof).

25 Further, antisense and ribozyme molecules that inhibit expression of the target gene can also be used in accordance with the invention to reduce the level of target gene expression, thus effectively reducing the level of target gene activity. Still further, triple helix molecules can be utilized in reducing the level of target gene activity. Antisense, ribozyme and triple helix molecules are discussed above.

30 It is possible that the use of antisense, ribozyme, and/or triple helix molecules to reduce or inhibit mutant gene expression can also reduce or inhibit the transcription (triple helix) and/or translation (antisense, ribozyme) of mRNA produced by normal target gene alleles, such that the concentration of normal target gene product present can be lower than

is necessary for a normal phenotype. In such cases, nucleic acid molecules that encode and express target gene polypeptides exhibiting normal target gene activity can be introduced into cells via gene therapy method. Alternatively, in instances in that the target gene encodes an extracellular protein, it can be preferable to co-administer normal target gene 5 protein into the cell or tissue in order to maintain the requisite level of cellular or tissue target gene activity.

Another method by which nucleic acid molecules may be utilized in treating or preventing a disease characterized by 47508 expression is through the use of aptamer molecules specific for 47508 protein. Aptamers are nucleic acid molecules having a tertiary 10 structure which permits them to specifically bind to protein ligands (see, e.g., Osborne, *et al.* (1997) *Curr. Opin. Chem Biol.* 1: 5-9; and Patel, D.J. (1997) *Curr Opin Chem Biol* 1:32-46). Since nucleic acid molecules may in many cases be more conveniently introduced into target cells than therapeutic protein molecules may be, aptamers offer a method by which 47508 protein activity may be specifically decreased without the introduction of drugs or 15 other molecules which may have pluripotent effects.

Antibodies can be generated that are both specific for target gene product and that reduce target gene product activity. Such antibodies may, therefore, be administered in instances whereby negative modulatory techniques are appropriate for the treatment of 47508 disorders. For a description of antibodies, see the Antibody section above.

20 In circumstances wherein injection of an animal or a human subject with a 47508 protein or epitope for stimulating antibody production is harmful to the subject, it is possible to generate an immune response against 47508 through the use of anti-idiotypic antibodies (see, for example, Herlyn, D. (1999) *Ann Med* 31:66-78; and Bhattacharya-Chatterjee, M., and Foon, K.A. (1998) *Cancer Treat Res.* 94:51-68). If an anti-idiotypic antibody is 25 introduced into a mammal or human subject, it should stimulate the production of anti-anti-idiotypic antibodies, which should be specific to the 47508 protein. Vaccines directed to a disease characterized by 47508 expression may also be generated in this fashion.

In instances where the target antigen is intracellular and whole antibodies are used, internalizing antibodies may be preferred. Lipofectin or liposomes can be used to deliver 30 the antibody or a fragment of the Fab region that binds to the target antigen into cells. Where fragments of the antibody are used, the smallest inhibitory fragment that binds to the target antigen is preferred. For example, peptides having an amino acid sequence corresponding to the Fv region of the antibody can be used. Alternatively, single chain

neutralizing antibodies that bind to intracellular target antigens can also be administered. Such single chain antibodies can be administered, for example, by expressing nucleotide sequences encoding single-chain antibodies within the target cell population (see e.g., Marasco *et al.* (1993) *Proc. Natl. Acad. Sci. USA* 90:7889-7893).

5 The identified compounds that inhibit target gene expression, synthesis and/or activity can be administered to a patient at therapeutically effective doses to prevent, treat or ameliorate 47508 disorders. A therapeutically effective dose refers to that amount of the compound sufficient to result in amelioration of symptoms of the disorders. Toxicity and therapeutic efficacy of such compounds can be determined by standard pharmaceutical 10 procedures as described above.

The data obtained from the cell culture assays and animal studies can be used in formulating a range of dosage for use in humans. The dosage of such compounds lies preferably within a range of circulating concentrations that include the ED₅₀ with little or no toxicity. The dosage can vary within this range depending upon the dosage form employed 15 and the route of administration utilized. For any compound used in the method of the invention, the therapeutically effective dose can be estimated initially from cell culture assays. A dose can be formulated in animal models to achieve a circulating plasma concentration range that includes the IC₅₀ (i.e., the concentration of the test compound that achieves a half-maximal inhibition of symptoms) as determined in cell culture. Such 20 information can be used to more accurately determine useful doses in humans. Levels in plasma can be measured, for example, by high performance liquid chromatography.

Another example of determination of effective dose for an individual is the ability to directly assay levels of "free" and "bound" compound in the serum of the test subject. Such assays may utilize antibody mimics and/or "biosensors" that have been created through 25 molecular imprinting techniques. The compound which is able to modulate 47508 activity is used as a template, or "imprinting molecule", to spatially organize polymerizable monomers prior to their polymerization with catalytic reagents. The subsequent removal of the imprinted molecule leaves a polymer matrix which contains a repeated "negative image" of the compound and is able to selectively rebind the molecule under biological assay 30 conditions. A detailed review of this technique can be seen in Ansell, R. J. *et al* (1996) *Current Opinion in Biotechnology* 7:89-94 and in Shea, K.J. (1994) *Trends in Polymer Science* 2:166-173. Such "imprinted" affinity matrixes are amenable to ligand-binding assays, whereby the immobilized monoclonal antibody component is replaced by an

appropriately imprinted matrix. An example of the use of such matrixes in this way can be seen in Vlatakis, G. *et al* (1993) *Nature* 361:645-647. Through the use of isotope-labeling, the "free" concentration of compound which modulates the expression or activity of 47508 can be readily monitored and used in calculations of IC₅₀.

5 Such "imprinted" affinity matrixes can also be designed to include fluorescent groups whose photon-emitting properties measurably change upon local and selective binding of target compound. These changes can be readily assayed in real time using appropriate fiberoptic devices, in turn allowing the dose in a test subject to be quickly optimized based on its individual IC₅₀. An rudimentary example of such a "biosensor" is
10 discussed in Kriz, D. *et al* (1995) *Analytical Chemistry* 67:2142-2144.

Another aspect of the invention pertains to methods of modulating 47508 expression or activity for therapeutic purposes. Accordingly, in an exemplary embodiment, the modulatory method of the invention involves contacting a cell with a 47508 or agent that modulates one or more of the activities of 47508 protein activity associated with the cell.

15 An agent that modulates 47508 protein activity can be an agent as described herein, such as a nucleic acid or a protein, a naturally-occurring target molecule of a 47508 protein (e.g., a 47508 substrate or receptor), a 47508 antibody, a 47508 agonist or antagonist, a peptidomimetic of a 47508 agonist or antagonist, or other small molecule.

In one embodiment, the agent stimulates one or 47508 activities. Examples of such
20 stimulatory agents include active 47508 protein and a nucleic acid molecule encoding 47508. In another embodiment, the agent inhibits one or more 47508 activities. Examples of such inhibitory agents include antisense 47508 nucleic acid molecules, anti-47508 antibodies, and 47508 inhibitors. These modulatory methods can be performed *in vitro* (e.g., by culturing the cell with the agent) or, alternatively, *in vivo* (e.g., by administering the
25 agent to a subject). As such, the present invention provides methods of treating an individual afflicted with a disease or disorder characterized by aberrant or unwanted expression or activity of a 47508 protein or nucleic acid molecule. In one embodiment, the method involves administering an agent (e.g., an agent identified by a screening assay described herein), or combination of agents that modulates (e.g., up regulates or down
30 regulates) 47508 expression or activity. In another embodiment, the method involves administering a 47508 protein or nucleic acid molecule as therapy to compensate for reduced, aberrant, or unwanted 47508 expression or activity.

Stimulation of 47508 activity is desirable in situations in which 47508 is abnormally downregulated and/or in which increased 47508 activity is likely to have a beneficial effect. For example, stimulation of 47508 activity is desirable in situations in which a 47508 is downregulated and/or in which increased 47508 activity is likely to have a beneficial effect.

5 Likewise, inhibition of 47508 activity is desirable in situations in which 47508 is abnormally upregulated and/or in which decreased 47508 activity is likely to have a beneficial effect.

Pharmacogenomics

The 47508 molecules of the present invention, as well as agents, or modulators which have a stimulatory or inhibitory effect on 47508 activity (e.g., 47508 gene expression) as identified by a screening assay described herein can be administered to individuals to treat (prophylactically or therapeutically) 47508 associated disorders (e.g., cellular proliferative and/or differentiative disorders) associated with aberrant or unwanted 47508 activity. In conjunction with such treatment, pharmacogenomics (i.e., the study of the relationship between an individual's genotype and that individual's response to a foreign compound or drug) may be considered. Differences in metabolism of therapeutics can lead to severe toxicity or therapeutic failure by altering the relation between dose and blood concentration of the pharmacologically active drug. Thus, a physician or clinician may consider applying knowledge obtained in relevant pharmacogenomics studies in determining whether to administer a 47508 molecule or 47508 modulator as well as tailoring the dosage and/or therapeutic regimen of treatment with a 47508 molecule or 47508 modulator.

Pharmacogenomics deals with clinically significant hereditary variations in the response to drugs due to altered drug disposition and abnormal action in affected persons. See, for example, Eichelbaum, M. *et al.* (1996) *Clin. Exp. Pharmacol. Physiol.* 23:983-985 and Linder, M.W. *et al.* (1997) *Clin. Chem.* 43:254-266. In general, two types of pharmacogenetic conditions can be differentiated. Genetic conditions transmitted as a single factor altering the way drugs act on the body (altered drug action) or genetic conditions transmitted as single factors altering the way the body acts on drugs (altered drug metabolism). These pharmacogenetic conditions can occur either as rare genetic defects or as naturally-occurring polymorphisms. For example, glucose-6-phosphate dehydrogenase deficiency (G6PD) is a common inherited enzymopathy in which the main clinical

complication is haemolysis after ingestion of oxidant drugs (anti-malarials, sulfonamides, analgesics, nitrofurans) and consumption of fava beans.

One pharmacogenomics approach to identifying genes that predict drug response, known as "a genome-wide association", relies primarily on a high-resolution map of the 5 human genome consisting of already known gene-related markers (e.g., a "bi-allelic" gene marker map which consists of 60,000-100,000 polymorphic or variable sites on the human genome, each of which has two variants.) Such a high-resolution genetic map can be compared to a map of the genome of each of a statistically significant number of patients taking part in a Phase II/III drug trial to identify markers associated with a particular 10 observed drug response or side effect. Alternatively, such a high resolution map can be generated from a combination of some ten-million known single nucleotide polymorphisms (SNPs) in the human genome. As used herein, a "SNP" is a common alteration that occurs in a single nucleotide base in a stretch of DNA. For example, a SNP may occur once per every 1000 bases of DNA. A SNP may be involved in a disease process, however, the vast 15 majority may not be disease-associated. Given a genetic map based on the occurrence of such SNPs, individuals can be grouped into genetic categories depending on a particular pattern of SNPs in their individual genome. In such a manner, treatment regimens can be tailored to groups of genetically similar individuals, taking into account traits that may be common among such genetically similar individuals.

20 Alternatively, a method termed the "candidate gene approach," can be utilized to identify genes that predict drug response. According to this method, if a gene that encodes a drug's target is known (e.g., a 47508 protein of the present invention), all common variants of that gene can be fairly easily identified in the population and it can be determined if having one version of the gene versus another is associated with a particular drug response.

25 Alternatively, a method termed the "gene expression profiling," can be utilized to identify genes that predict drug response. For example, the gene expression of an animal dosed with a drug (e.g., a 47508 molecule or 47508 modulator of the present invention) can give an indication whether gene pathways related to toxicity have been turned on.

Information generated from more than one of the above pharmacogenomics 30 approaches can be used to determine appropriate dosage and treatment regimens for prophylactic or therapeutic treatment of an individual. This knowledge, when applied to dosing or drug selection, can avoid adverse reactions or therapeutic failure and thus enhance therapeutic or prophylactic efficiency when treating a subject with a 47508 molecule or

47508 modulator, such as a modulator identified by one of the exemplary screening assays described herein.

The present invention further provides methods for identifying new agents, or combinations, that are based on identifying agents that modulate the activity of one or more of the gene products encoded by one or more of the 47508 genes of the present invention, wherein these products may be associated with resistance of the cells to a therapeutic agent. Specifically, the activity of the proteins encoded by the 47508 genes of the present invention can be used as a basis for identifying agents for overcoming agent resistance. By blocking the activity of one or more of the resistance proteins, target cells, e.g., human cells, will 10 become sensitive to treatment with an agent that the unmodified target cells were resistant to.

Monitoring the influence of agents (e.g., drugs) on the expression or activity of a 47508 protein can be applied in clinical trials. For example, the effectiveness of an agent determined by a screening assay as described herein to increase 47508 gene expression, 15 protein levels, or upregulate 47508 activity, can be monitored in clinical trials of subjects exhibiting decreased 47508 gene expression, protein levels, or downregulated 47508 activity. Alternatively, the effectiveness of an agent determined by a screening assay to decrease 47508 gene expression, protein levels, or downregulate 47508 activity, can be monitored in clinical trials of subjects exhibiting increased 47508 gene expression, protein 20 levels, or upregulated 47508 activity. In such clinical trials, the expression or activity of a 47508 gene, and preferably, other genes that have been implicated in, for example, a 47508-associated disorder can be used as a "read out" or markers of the phenotype of a particular cell.

47508 Informatics

25 The sequence of a 47508 molecule is provided in a variety of media to facilitate use thereof. A sequence can be provided as a manufacture, other than an isolated nucleic acid or amino acid molecule, which contains a 47508. Such a manufacture can provide a nucleotide or amino acid sequence, e.g., an open reading frame, in a form which allows examination of the manufacture using means not directly applicable to examining the nucleotide or amino 30 acid sequences, or a subset thereof, as they exists in nature or in purified form. The sequence information can include, but is not limited to, 47508 full-length nucleotide and/or amino acid sequences, partial nucleotide and/or amino acid sequences, polymorphic

sequences including single nucleotide polymorphisms (SNPs), epitope sequence, and the like. In a preferred embodiment, the manufacture is a machine-readable medium, e.g., a magnetic, optical, chemical or mechanical information storage device.

As used herein, "machine-readable media" refers to any medium that can be read and accessed directly by a machine, e.g., a digital computer or analogue computer. Non-limiting examples of a computer include a desktop PC, laptop, mainframe, server (e.g., a web server, network server, or server farm), handheld digital assistant, pager, mobile telephone, and the like. The computer can be stand-alone or connected to a communications network, e.g., a local area network (such as a VPN or intranet), a wide area network (e.g., an Extranet or the Internet), or a telephone network (e.g., a wireless, DSL, or ISDN network). Machine-readable media include, but are not limited to: magnetic storage media, such as floppy discs, hard disc storage medium, and magnetic tape; optical storage media such as CD-ROM; electrical storage media such as RAM, ROM, EPROM, EEPROM, flash memory, and the like; and hybrids of these categories such as magnetic/optical storage media.

A variety of data storage structures are available to a skilled artisan for creating a machine-readable medium having recorded thereon a nucleotide or amino acid sequence of the present invention. The choice of the data storage structure will generally be based on the means chosen to access the stored information. In addition, a variety of data processor programs and formats can be used to store the nucleotide sequence information of the present invention on computer readable medium. The sequence information can be represented in a word processing text file, formatted in commercially-available software such as WordPerfect and Microsoft Word, or represented in the form of an ASCII file, stored in a database application, such as DB2, Sybase, Oracle, or the like. The skilled artisan can readily adapt any number of data processor structuring formats (e.g., text file or database) in order to obtain computer readable medium having recorded thereon the nucleotide sequence information of the present invention.

In a preferred embodiment, the sequence information is stored in a relational database (such as Sybase or Oracle). The database can have a first table for storing sequence (nucleic acid and/or amino acid sequence) information. The sequence information can be stored in one field (e.g., a first column) of a table row and an identifier for the sequence can be stored in another field (e.g., a second column) of the table row. The database can have a second table, e.g., storing annotations. The second table can have a field for the sequence identifier, a field for a descriptor or annotation text (e.g., the descriptor can refer to

a functionality of the sequence, a field for the initial position in the sequence to which the annotation refers, and a field for the ultimate position in the sequence to which the annotation refers. Non-limiting examples for annotation to nucleic acid sequences include polymorphisms (e.g., SNP's) translational regulatory sites and splice junctions. Non-
5 limiting examples for annotations to amino acid sequence include polypeptide domains, e.g., a domain described herein; active sites and other functional amino acids; and modification sites.

By providing the nucleotide or amino acid sequences of the invention in computer readable form, the skilled artisan can routinely access the sequence information for a variety
10 of purposes. For example, one skilled in the art can use the nucleotide or amino acid sequences of the invention in computer readable form to compare a target sequence or target structural motif with the sequence information stored within the data storage means. A search is used to identify fragments or regions of the sequences of the invention which match a particular target sequence or target motif. The search can be a BLAST search or
15 other routine sequence comparison, e.g., a search described herein.

Thus, in one aspect, the invention features a method of analyzing 47508, e.g., analyzing structure, function, or relatedness to one or more other nucleic acid or amino acid sequences. The method includes: providing a 47508 nucleic acid or amino acid sequence; comparing the 47508 sequence with a second sequence, e.g., one or more preferably a plurality of sequences from a collection of sequences, e.g., a nucleic acid or protein sequence database to thereby analyze 47508. The method can be performed in a machine, e.g., a computer, or manually by a skilled artisan.
20

The method can include evaluating the sequence identity between a 47508 sequence and a database sequence. The method can be performed by accessing the database at a
25 second site, e.g., over the Internet.

As used herein, a "target sequence" can be any DNA or amino acid sequence of six or more nucleotides or two or more amino acids. A skilled artisan can readily recognize that the longer a target sequence is, the less likely a target sequence will be present as a random occurrence in the database. Typical sequence lengths of a target sequence are from about 10
30 to 100 amino acids or from about 30 to 300 nucleotide residues. However, it is well recognized that commercially important fragments, such as sequence fragments involved in gene expression and protein processing, may be of shorter length.

Computer software is publicly available which allows a skilled artisan to access sequence information provided in a computer readable medium for analysis and comparison to other sequences. A variety of known algorithms are disclosed publicly and a variety of commercially available software for conducting search means are and can be used in the 5 computer-based systems of the present invention. Examples of such software include, but are not limited to, MacPattern (EMBL), BLASTN and BLASTX (NCBI).

Thus, the invention features a method of making a computer readable record of a sequence of a 47508 sequence which includes recording the sequence on a computer readable matrix. In a preferred embodiment the record includes one or more of the 10 following: identification of an ORF; identification of a domain, region, or site; identification of the start of transcription; identification of the transcription terminator; the full length amino acid sequence of the protein, or a mature form thereof; the 5' end of the translated region.

In another aspect, the invention features, a method of analyzing a sequence. The 15 method includes: providing a 47508 sequence, or record, in machine-readable form; comparing a second sequence to the 47508 sequence; thereby analyzing a sequence. Comparison can include comparing to sequences for sequence identity or determining if one sequence is included within the other, e.g., determining if the 47508 sequence includes a sequence being compared. In a preferred embodiment the 47508 or second sequence is 20 stored on a first computer, e.g., at a first site and the comparison is performed, read, or recorded on a second computer, e.g., at a second site. E.g., the 47508 or second sequence can be stored in a public or proprietary database in one computer, and the results of the comparison performed, read, or recorded on a second computer. In a preferred embodiment the record includes one or more of the following: identification of an ORF; identification of 25 a domain, region, or site; identification of the start of transcription; identification of the transcription terminator; the full length amino acid sequence of the protein, or a mature form thereof; the 5' end of the translated region.

In another aspect, the invention provides a machine-readable medium for holding 30 instructions for performing a method for determining whether a subject has a 47508-associated disease or disorder or a pre-disposition to a 47508-associated disease or disorder, wherein the method comprises the steps of determining 47508 sequence information associated with the subject and based on the 47508 sequence information, determining whether the subject has a 47508-associated disease or disorder or a pre-disposition to a

47508-associated disease or disorder and/or recommending a particular treatment for the disease, disorder or pre-disease condition.

The invention further provides in an electronic system and/or in a network, a method for determining whether a subject has a 47508-associated disease or disorder or a pre-disposition to a disease associated with a 47508 wherein the method comprises the steps of determining 47508 sequence information associated with the subject, and based on the 47508 sequence information, determining whether the subject has a 47508-associated disease or disorder or a pre-disposition to a 47508-associated disease or disorder, and/or recommending a particular treatment for the disease, disorder or pre-disease condition. In a preferred embodiment, the method further includes the step of receiving information, e.g., phenotypic or genotypic information, associated with the subject and/or acquiring from a network phenotypic information associated with the subject. The information can be stored in a database, e.g., a relational database. In another embodiment, the method further includes accessing the database, e.g., for records relating to other subjects, comparing the 47508 sequence of the subject to the 47508 sequences in the database to thereby determine whether the subject has a 47508-associated disease or disorder, or a pre-disposition for such.

The present invention also provides in a network, a method for determining whether a subject has a 47508 associated disease or disorder or a pre-disposition to a 47508-associated disease or disorder associated with 47508, said method comprising the steps of receiving 47508 sequence information from the subject and/or information related thereto, receiving phenotypic information associated with the subject, acquiring information from the network corresponding to 47508 and/or corresponding to a 47508-associated disease or disorder (e.g., cellular proliferative and/or differentiative disorders), and based on one or more of the phenotypic information, the 47508 information (e.g., sequence information and/or information related thereto), and the acquired information, determining whether the subject has a 47508-associated disease or disorder or a pre-disposition to a 47508-associated disease or disorder. The method may further comprise the step of recommending a particular treatment for the disease, disorder or pre-disease condition.

The present invention also provides a method for determining whether a subject has a 47508 -associated disease or disorder or a pre-disposition to a 47508-associated disease or disorder, said method comprising the steps of receiving information related to 47508 (e.g., sequence information and/or information related thereto), receiving phenotypic information associated with the subject, acquiring information from the network related to 47508 and/or

related to a 47508-associated disease or disorder, and based on one or more of the phenotypic information, the 47508 information, and the acquired information, determining whether the subject has a 47508-associated disease or disorder or a pre-disposition to a 47508-associated disease or disorder. The method may further comprise the step of 5 recommending a particular treatment for the disease, disorder or pre-disease condition.

This invention is further illustrated by the following examples that should not be construed as limiting. The contents of all references, patents and published patent applications cited throughout this application are incorporated herein by reference.

EXAMPLES

10 Example 1: Identification and Characterization of Human 47508 cDNA

The human 47508 nucleic acid sequence is recited as follows:

CGGAGCTTCCGAACCAGGCGGGATTCCACCGGGTATTCGCTCGGGAGGCAGGACTTCGG
GCTTGATGGCGTTGGGGTGGCTTCTGCAGGCTCTGTGTCGAAACACTGGC
GGGGCAGGGCAAATCGGCCAGAGCTCTGCCAGAGGACGGCTAAGCCGGGGCGT
15 GTCCTGGCTGGCCCCACCCGCGCCCGCCCGCCCGCCGGCTCGGGAGCTGCCA
GCTTGGAGGGCCGGCCGGATGCTACACACAACCCAGCTGTACAGCATGCCAG
AGACACGCTGGCAAATCGTGTACTCGCCGCGCTACAACATCACCTTATGGCCTGGAGA
AGCTGCATCCCTTGATGCCGAAAATGGGCAAAGTGTCAATTCTAAAGAGAAGA
AGCTTCGTCTGACAGCATGCTGGTGGAGGCGGGAGGCCTCGGAGGAGGACCTGCTGG
20 TGGTGCACACGAGGCGCTATCTTAATGAGCTCAAGTGGTCCTTGCTGTGCTACCATCA
CAGAAATCCCCCGTTATCTTCCTCCCCAACTCCTGTGCAAGAGGAAGGTGCTGAGGC
CCCTTCGGACCCAGACAGGAGGAACCATAATGCCGGGAAGCTGGCTGTGGAGCGAGGCT
GGGCCATCAACGTGGGGTGGCTTCCACACTGCTCCAGCGACCGTGGCGGGGCTCT
GTGCCTATGCGGACATCACGCTGCCATCAAGTTCTGTTGAGCGTGTGGAGGGCATCT
25 CCAGGGCTACCATCATTGATCTTGATGCCATCAGGGCAATGGCATGAGCGAGACTCA
TGGACGACAAGCGTGTACATCATGGATGTCTACAACCGCCACATCTACCCAGGGAC
GCTTGGCAAGCAGGCCATCAGGCGGAAGGTGGAGCTGGAGTGGGCACAGAGGATGATG
AGTACCTGGATAAGGTGGAGAGGAACATCAAGAAATCCCTCCAGGAGCACCTGCCGACG
TGGTGGTATACAATGCAGGCACCGACATCCTCGAGGGGACCGCCTGGGGGCTGTCCA
30 TCAGCCCAGCGGGCATCGTGAAGCGGGATGAGCTGGTGTCCGGATGGTCCGTGGCGCC
GGGTGCCCATCCTTATGGTGACCTCAGGCGGGTACCAAGAGCGCACAGCCCGCATATTG
CTGACTCCATACTTAATCTGTTGGCCTGGGCTCATTGGCCTGAGTCACCCAGCGTCT
CCGCACAGAACTCAGACACACCGCTGCTCCCCCTGCAGTGCCCTGACCCCTTGCTGCCCT

GCCTGTACGTGGCCCTGCCTATCCGCCCCCTAGTGCTTTGTTCTAACCTCATGGG
GTGGTGGAGGCAGCCTTCAGTGAGCATGGAGGGCAGGGCCATCCCTGGCTGGGCCTGG
ACCTGGCCCTTCCCTACTTTCCCTGCTGGAAGCCAGAAGGGCTGAGGCCTATGGG
TGGGGGCAGAAGGCAGAGCCTGTGTCAGGGGACCCACACGAAGTCACCAGCCCAG
5 GTCCAGGGAGGCAGGCAGG (SEQ ID NO:1).

The human 47508 sequence (Fig. 1; SEQ ID NO:1), which is approximately 1579 nucleotides long. The nucleic acid sequence includes an initiation codon (ATG) and a termination codon (TGA) which are underscored above. The region between and inclusive of the initiation codon and the termination codon is a methionine-initiated coding sequence 10 of about 1242 nucleotides, including the termination codon (nucleotides indicated as “coding” of SEQ ID NO:1; SEQ ID NO:3). The coding sequence encodes a 413 amino acid protein (SEQ ID NO:2), which is recited as follows:

MGVGGGLPAGRLSVSQHWRGGPNRPELCPQRTRLSPGACPGLAPPAPRAPPGRGAAASF
GRAGPGMLHTTQLYQHVPETRWPIVYSPRYNITFMGLEKLHPFDAGKGKVINFLKEEKL
15 LSDSMLVEAREASEEDLLVVHTRRYLNELKWSFAVATITEIPPVIFLPNFLVQRKVLRPL
RTQTGGTIMAGKLAVERGWAINVGGGFHHCSSDRGGFCAYADITLAIKFLFERVEGISR
ATIIDLDQGNQHHERDFMDDKRVYIMDVYRHIYPGDRFAKQAIRRKVELEWGTEDDEY
LDKVERNIKKSLQEHLPDVVVYNAGTDILEGDRLLGGLSISPAGIVKRDELVFRMVRGRRV
PILMVTSGGYQKRTARIIADSILNLFGLGLIGPESPSVSAQNSDTPLLPPAVP (SEQ ID
20 NO:2).

Example 2: Tissue Distribution of 47508 mRNA by TaqMan Analysis

Endogenous human 47508 gene expression was determined using the Perkin-Elmer/ABI 7700 Sequence Detection System which employs TaqMan technology. Briefly, TaqMan technology relies on standard RT-PCR with the addition of a third gene-specific 25 oligonucleotide (referred to as a probe) which has a fluorescent dye coupled to its 5' end (typically 6-FAM) and a quenching dye at the 3' end (typically TAMRA). When the fluorescently tagged oligonucleotide is intact, the fluorescent signal from the 5' dye is quenched. As PCR proceeds, the 5' to 3' nucleolytic activity of Taq polymerase digests the labeled primer, producing a free nucleotide labeled with 6-FAM, which is now detected as a 30 fluorescent signal. The PCR cycle where fluorescence is first released and detected is directly proportional to the starting amount of the gene of interest in the test sample, thus providing a quantitative measure of the initial template concentration. Samples can be internally controlled by the addition of a second set of primers/probe specific for a

housekeeping gene such as GAPDH which has been labeled with a different fluorophore on the 5' end (typically VIC).

To determine the level of 47508 in various human tissues a primer/probe set was designed. Total RNA was prepared from a series of human tissues using an RNeasy kit from Qiagen. First strand cDNA was prepared from 1 µg total RNA using an oligo-dT primer and Superscript II reverse transcriptase (Gibco/BRL). cDNA obtained from approximately 50 ng total RNA was used per TaqMan reaction. Tissues tested include the human tissues and several cell lines shown in Tables 1-4. 47508 mRNA was detected in all tissues and cell lines analyzed (Tables 1-4), including normal and cancerous tissues of the breast, ovary, lung, and colon (Table 1).

Table 1

Tissue	Relative Expression
PIT 400 Breast Normal	1.56
PIT 372 Breast Normal	1.99
CHT 558 Breast Normal	0.47
CLN 168 Breast Tumor: IDC	11.20
MDA 304 Breast Tumor: moderately differentiated IDC	0.71
NDR 57 Breast Tumor: poorly differentiated IDC	4.19
NDR 132 Breast Tumor: IDC/ILC	10.10
CHT 562 Breast Tumor: IDC	20.69
NDR 12 Breast Tumor	19.17
PIT 208 Ovary Normal	7.04
CHT 620 Ovary Normal	5.98
CLN 03 Ovary Tumor	2.78
CLN 17 Ovary Tumor	9.42
MDA 25 Ovary Tumor	18.52
MDA 216 Ovary Tumor	6.26
CLN 012 Ovary Tumor	13.51
MDA 185 Lung Normal	0.76
CLN 930 Lung Normal	2.04
MDA 183 Lung Normal	0.51
MPI 215 Lung Tumor: SmC	2.21
MDA 259 Lung Tumor: PDNSCCL	2.87
CHT 832 Lung Tumor: PDNSCCL	3.09
CHT 911 Lung Tumor: SCC	3.52
MDA 262 Lung Tumor: SCC	10.97
CHT 211 Lung Tumor: adenocarcinoma	2.72
MDA 253 Lung Tumor: PDNSCCL	0.46
NHBE	27.68
CHT 396 Colon Normal	21.87
CHT 523 Colon Normal	2.17

CHT 452 Colon Normal	0.55
CHT 382 Colon Tumor: moderately differentiated	6.09
CHT 528 Colon Tumor: moderately differentiated	4.65
CLN 609 Colon Tumor	4.91
CHT 372 Colon Tumor: poorly/moderately differentiated	3.27
NDR 217 Colon-Liver Metastasis	3.38
NDR 100 Colon-Liver Metastasis	7.26
PIT 260 Liver Normal (female)	0.21
ONC 102 Hemangioma	0.67
A24 HMVEC Arrested	3.01
C48 HMVEC Proliferating	3.97

As shown in table 1, 47508 is expressed in normal breast, ovary, lung, colon, liver, and endothelial cells, as well as tumors of the breast, ovary, lung, colon, and liver (metastases originating from the colon). In most breast tumors analyzed, 47508 expression is elevated relative to that observed in normal breast tissue. In addition, a subset of ovary and lung tumors display an increase in 47508 expression, and all of the colon tumor samples display an increase in 47508 expression relative to the majority of normal colon tissue samples analyzed. Abbreviations used in Table 1 include: IDC – invasive ductal carcinoma; ILC – invasive lobular carcinoma; SmC - ; PDNSCCL – poorly differentiated non-small cell carcinoma of the lung; SCC – squamous cell carcinoma; and HMVEC – human vein endothelial cells.

Table 2

Cell Line	Relative Expression
MCF10MS	16.35
MCF10A	10.27
MCF10AT.cl1	12.47
MCF10AT.cl3	12.74
MCF10AT1	6.92
MCF10AT3B	10.64
MCF10CA1a.cl1	6.90
MCF10CA1a.cl1 Agar	16.63
MCF10A.m25 Plastic	18.65
MCF10CA Agar	10.13
MCF10CA Plastic	4.41
MCF3B Agar	23.60
MCF3B Plastic	14.28
MCF10A EGF 0 hr	6.30
MCF10A EGF 0.5 hr	6.78
MCF10A EGF 1 hr	5.96
MCF10A EGF 2 hr	5.43
MCF10A EGF 4 hr	7.21

MCF10A EGF 8 hr	5.66
MCF10A IGF1A 0 hr	18.84
MCF10A IGF1A 0.5 hr	25.30
MCF10A IGF1A 1 hr	19.51
MCF10A IGF1A 3 hr	32.69
MCF10A IGF1A 24 hr	51.30
MCF10AT3B.cl5 Plastic	15.15
MCF10AT3B.cl6 Plastic	23.52
MCF10AT3B.cl3 Plastic	22.17
MCF10AT3B.cl1 Plastic	26.10
MCF10AT3B.cl4 Plastic	11.88
MCF10AT3B.cl2 Plastic	25.03
MCF10AT3B.cl5 Agar	29.36
MCF10AT3B.cl6 Agar	35.28
MCF-7	116.23
ZR-75	40.11
T47D	54.22
MDA-231	11.76
MDA-435	10.42
SkBr3	49.89
Hs578Bst	6.17
Hs578T	9.29

As shown in table 2, 47508 mRNA is expressed in many different cell lines derived from breast tumors, and under many different culture conditions. In some cell lines, e.g., MCF10CA, MCF3B, and MCF10AT3B.cl5 and cl6 cell lines, expression of 47508 is elevated in cells that are plated on agar, as compared to cells that are plated on plastic. Cells that are plated on agar tend to have a more transformed phenotype, so the increase in 47508 expression in breast tumor cells plated on agar is consistent with the increase in 47508 expression observed in many tumors (see Table 1). In addition, MCF10A cells display an increase in 47508 expression in response to Insulin Growth Factor (IGF) 1A after 3 hours, with an even larger increase in 47508 expression after 24 hours of exposure to IGF1A.

Table 3

Cell Line	Relative Expression
H460 +p16 24hr	1.15
H460 +p16 48hr	0.72
H460 +p16 72hr	0.41
H460 +p16 96hr	0.28
H460 -p16 24hr	0.32
H460 -p16 48hr	0.48
H460 -p16 72hr	0.23

H460 -p16 96hr	0.44
H460 -p16 24hr	0.29
H460 -p16 48hr	0.47
H460 -p16 72hr	0.29
H460 -p16 96hr	0.45
H460 +p16 48hr	0.34
H460 +p16 72hr	0.44
H460 +p16 96hr	0.22

As shown in Table 3, H460 large cell lung carcinoma cells express 47508 in both the presence and absence of the tumor suppressor gene, p16.

5 **Table 4**

Cell Line	Relative Expression
NHBE	43.59
A549 (BA)	36.78
H460 (LCLC)	1.91
H23 (AC)	36.02
H522 (AC)	62.28
H125 (AC/SCC)	56.52
H520 (SCC)	26.01
H69 (SCLC)	3.25
H345 (SCLC)	42.25
H460 INCX 24hr	1.91
H460 p16 24hr	2.91
H460 INCX 48hr	1.65
H460 p16 48hr	2.20
H460 INCX Stable Plas	3.75
H460 p16 Stable Plas	3.40
H460 NA-Agar	1.19
H460 Incx stable Agar	0.38
H460 p16 stable Agar	0.90
H125 Incx 96hr	43.74
H125 p53 96hr	36.52
H345 Mock 144hr	66.06
H345 Gluc 144hr	42.54
H345 VIP 144hr	80.21

As shown in Table 4, a number of different lung cell lines express 47508, with neither the p16 or p53 tumor suppressor genes having a strong impact on 47508 expression under the conditions examined. Expression of 47508 is lowest in the H460 large cell lung carcinoma cells. Abbreviations used in Table 4 include: NHBE - primary normal human

bronchial epithelial cells; LCLC – large cell lung carcinoma; AC – adenocarcinoma; SCC – squamous cell carcinoma; SCLC – small cell lung carcinoma; INCX; Gluc; and VIP.

Example 3: Tissue Distribution of 47508 mRNA by Northern Analysis

Northern blot hybridizations with various RNA samples can be performed under 5 standard conditions and washed under stringent conditions, i.e., 0.2xSSC at 65°C. A DNA probe corresponding to all or a portion of the 47508 cDNA (SEQ ID NO:1) can be used. The DNA was radioactively labeled with ^{32}P -dCTP using the Prime-It Kit (Stratagene, La Jolla, CA) according to the instructions of the supplier. Filters containing mRNA from mouse hematopoietic and endocrine tissues, and cancer cell lines (Clontech, Palo Alto, CA) 10 can be probed in ExpressHyb hybridization solution (Clontech) and washed at high stringency according to manufacturer's recommendations.

Example 4: Recombinant Expression of 47508 in Bacterial Cells

In this example, 47508 is expressed as a recombinant glutathione-S-transferase (GST) fusion polypeptide in *E. coli* and the fusion polypeptide is isolated and characterized. 15 Specifically, 47508 is fused to GST and this fusion polypeptide is expressed in *E. coli*, e.g., strain PEB199. Expression of the GST-47508 fusion protein in PEB199 is induced with IPTG. The recombinant fusion polypeptide is purified from crude bacterial lysates of the induced PEB199 strain by affinity chromatography on glutathione beads. Using polyacrylamide gel electrophoretic analysis of the polypeptide purified from the bacterial 20 lysates, the molecular weight of the resultant fusion polypeptide is determined.

Example 5: Expression of Recombinant 47508 Protein in COS Cells

To express the 47508 gene in COS cells (e.g., COS-7 cells, CV-1 origin SV40 cells; Gluzman (1981) *Cell* 23:175-182), the pcDNA/Amp vector by Invitrogen Corporation (San Diego, CA) is used. This vector contains an SV40 origin of replication, an ampicillin 25 resistance gene, an *E. coli* replication origin, a CMV promoter followed by a polylinker region, and an SV40 intron and polyadenylation site. A DNA fragment encoding the entire 47508 protein and an HA tag (Wilson *et al.* (1984) *Cell* 37:767) or a FLAG tag fused in-frame to its 3' end of the fragment is cloned into the polylinker region of the vector, thereby placing the expression of the recombinant protein under the control of the CMV promoter.

To construct the plasmid, the 47508 DNA sequence is amplified by PCR using two primers. The 5' primer contains the restriction site of interest followed by approximately twenty nucleotides of the 47508 coding sequence starting from the initiation codon; the 3' end sequence contains complementary sequences to the other restriction site of interest, a 5 translation stop codon, the HA tag or FLAG tag and the last 20 nucleotides of the 47508 coding sequence. The PCR amplified fragment and the pCDNA/Amp vector are digested with the appropriate restriction enzymes and the vector is dephosphorylated using the CIAP enzyme (New England Biolabs, Beverly, MA). Preferably the two restriction sites chosen are different so that the 47508 gene is inserted in the correct orientation. The ligation 10 mixture is transformed into *E. coli* cells (strains HB101, DH5 α , SURE, available from Stratagene Cloning Systems, La Jolla, CA, can be used), the transformed culture is plated on ampicillin media plates, and resistant colonies are selected. Plasmid DNA is isolated from transformants and examined by restriction analysis for the presence of the correct fragment.

COS cells are subsequently transfected with the 47508-pcDNA/Amp plasmid DNA 15 using the calcium phosphate or calcium chloride co-precipitation methods, DEAE-dextran-mediated transfection, lipofection, or electroporation. Other suitable methods for transfecting host cells can be found in Sambrook, J., Fritsh, E. F., and Maniatis, T. (1989) *Molecular Cloning: A Laboratory Manual*. 2nd, ed., Cold Spring Harbor Laboratory, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY. The expression of the 47508 20 polypeptide is detected by radiolabelling (35 S-methionine or 35 S-cysteine available from NEN, Boston, MA, can be used) and immunoprecipitation (Harlow, E. and Lane, D. (1988) *Antibodies: A Laboratory Manual*, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY) using an HA specific monoclonal antibody. Briefly, the cells are labeled for 8 25 hours with 35 S-methionine (or 35 S-cysteine). The culture media are then collected and the cells are lysed using detergents (RIPA buffer, 150 mM NaCl, 1% NP-40, 0.1% SDS, 0.5% DOC, 50 mM Tris, pH 7.5). Both the cell lysate and the culture media are precipitated with an HA specific monoclonal antibody. Precipitated polypeptides are then analyzed by SDS-PAGE.

Alternatively, DNA containing the 47508 coding sequence is cloned directly into the 30 polylinker of the pCDNA/Amp vector using the appropriate restriction sites. The resulting plasmid is transfected into COS cells in the manner described above, and the expression of the 47508 polypeptide is detected by radiolabelling and immunoprecipitation using a 47508 specific monoclonal antibody.

Equivalents

Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments of the invention described herein. Such equivalents are intended to be encompassed by the following claims.

What is claimed is:

1. An isolated nucleic acid molecule selected from the group consisting of:
 - a) a nucleic acid comprising the nucleotide sequence of SEQ ID NO: 1, SEQ ID NO:3, or a complement thereof; and
 - 5 b) a nucleic acid molecule which encodes a polypeptide comprising the amino acid sequence of SEQ ID NO:2.
2. The nucleic acid molecule of claim 1, further comprising a vector nucleic acid sequence.
- 10 3. The nucleic acid molecule of claim 1, further comprising a nucleic acid sequence encoding a heterologous polypeptide.
4. A host cell which contains the nucleic acid molecule of claim 1.
- 15 5. An isolated polypeptide comprising the amino acid sequence of SEQ ID NO:2.
6. The polypeptide of claim 5, further comprising a heterologous amino acid sequence.
- 20 7. An antibody, or antigen binding fragment, which selectively binds to a polypeptide of claim 5.
8. A method for producing a polypeptide comprising the amino acid sequence of SEQ ID NO:2, comprising culturing the host cell of claim 4 under conditions in which the nucleic acid molecule is expressed.
- 25 9. A method for detecting the presence of a polypeptide of claim 5 in a sample, comprising:
 - a) contacting the sample with a compound which selectively binds to a polypeptide of claim 5; and
 - 30 b) determining whether the compound binds to the polypeptide in the sample.

10. The method of claim 9, wherein the compound which binds to the polypeptide is an antibody.
11. A kit comprising a compound which selectively binds to a polypeptide of claim 5 and instructions for use.
12. A method for detecting the presence of a nucleic acid molecule of claim 1 in a sample, comprising:
 - a) contacting the sample with a nucleic acid probe or primer which selectively hybridizes to the nucleic acid molecule; and
 - b) determining whether the nucleic acid probe or primer binds to a nucleic acid molecule in the sample.
13. The method of claim 12, wherein the sample comprises mRNA molecules and is contacted with a nucleic acid probe.
14. A kit comprising a nucleic acid probe which selectively hybridizes to a nucleic acid molecule of claim 1 and instructions for use.
- 20 15. A method for identifying a compound which binds to a polypeptide of claim 5 comprising:
 - a) contacting a polypeptide, or a cell expressing a polypeptide of claim 5 with a test compound; and
 - b) determining whether the polypeptide binds to the test compound.
- 25 16. A method for modulating the activity of a polypeptide of claim 5, comprising contacting a polypeptide or a cell expressing a polypeptide of claim 5 with a compound which binds to the polypeptide in a sufficient concentration to modulate the activity of the polypeptide.
- 30 17. A method of inhibiting aberrant activity of a 47508-expressing cell, comprising contacting the cell with a compound that modulates the activity or expression of a

polypeptide of claim 5, in an amount which is effective to reduce or inhibit the aberrant activity of the cell.

18. The method of claim 16, wherein the compound is selected from the group
5 consisting of a peptide, a phosphopeptide, a small organic molecule, and an antibody.

19. The method of claim 16, wherein the cell is located in a cancerous or pre-cancerous tissue.

10 20. A method of treating or preventing a disorder characterized by aberrant activity of a 47508-expressing cell, in a subject, comprising: administering to the subject an effective amount of a compound that modulates the activity or expression of a polypeptide of claim 5, such that the aberrant activity of the 47508-expressing cell is reduced or inhibited.

15

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Human 47508

Histone Deacetylase Domain

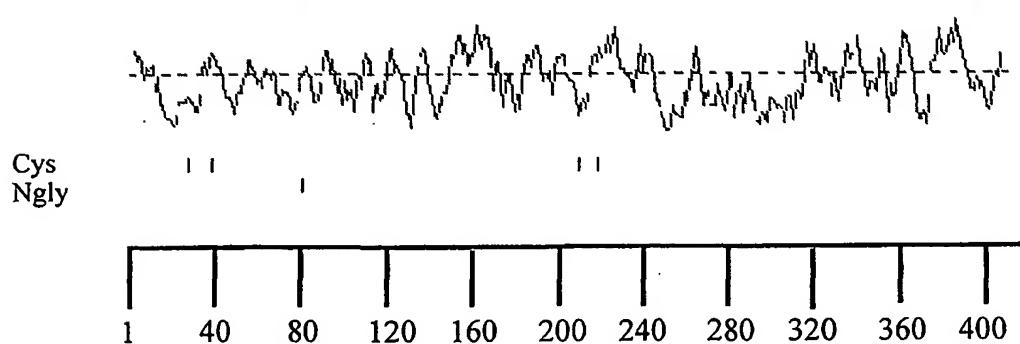


Figure 1

Hist_deacetyl: domain 1 of 1, from 83 to 392: score 84.6, E = 2e-21

Begin	SEQ ID NO: 4	* -> gyvydpev.1nheckisygatHpenpeR1rl1helleYg11kkmei
		++vy+p+++ +++ + + Hp++ ++ + + L+e +11 + + +
47508	(SEQ ID NO: 2)	83 PIVYSPRYNITEM---GLEKLHPFDAGRWGKVINFKEEKLLSDSML 126
		vtngrkataeelllvHsedyyvefleslsktnleelkgtdkilleiellky
		v+ +r+a+e+11+vH++ Y++1+ + + +++ + i+1 + +
47508	127 VE-AREASEEDLLVVHTRRYLNELKWSFAVATITEIP--PVIFL----PN 169	
		fnkgddtpvfraglyeaarlavGssleladrllegeldnafnwaggPghHA
		F V +++ r+ +Gg++ + + +e + a+n+GG HH+
47508	170 F-----LVQRKVLRPLRTQTGGTIMAGKLAVERG--WAINVGGG-FHHC 210	
		kkgeasGRCYfNNVAlAiky11kkkyPlyvkRV11iDfDvHHGDTQeiFy
		+++GFC + ++ +Aik 1+++ ++ R iID+D+H+G+G ++ F
47508	211 SSDRGGFCAYADITIAIKELFERY-EGISRATIIDDAHQGNGHERDEM 259	
		dddrv1tvsfHkygkGeFFPGtGdteiGkgkGkgyt1NiPlnedgtDd
		dd+rV +++ ++ ++PG +++++ ++ + + gt+D+
47508	260 DDKRKYIMDVYNRH---TYPGD----RFAKQAIRRKVELEW---GTEDD 298	
		sy1safkhv1epvleqFkPdaivisagFDalygDptqLgsfnltiegyge
		+Y1 + i++ 1 + + Pd++v+ aG D 1+gD+ Lg++ ++ g
47508	299 EYLDKVERNIKKSLQEHLPDVVVYNAGTFILEGDR--LGGLSISPAIVK 346	
		mvrf1ks1.aqkhcdgp11vv1LEGGYt1raia.nvarcwialtg.g11g <-* End SEQ ID NO:4
		+++ + +++ +p+1+v GGY . r a+ +a++ ++1+g g1+g
47508	347 RDELVFRMvGRR---VPILMVTSGGYQKR-TARIADSILNLFG1GLIG 392	SEQ ID NO:2

Figure 2

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>PD345193 p2001.1 HISTONE DEACETYLASE Length = 45
 Score = 228 (85.3 bits), Expect = 8.1e-19, P = 8.1e-19
 Identities = 39/45 (86%), Positives = 42/45 (93%)

```

SEQ ID NO:2 71 TQLYQHVPETRPIVYSPRYNITFMGLEKLHPPFDAGKGKVINF 115 SEQ ID NO:2
          TQLY HVPET WPI+YSPRYNITFMG+EKLHPPFDAGKG+V NFL
Begin SEQ ID NO:5 -> TQLYFHVPETPWIYSPRYNITFMGIEKLHPPFDAGKGRCVNFL <- End SEQ ID NO:5
  
```

Figure 3A

>PD001400 p2001.1 HISTONE DEACETYLASE Length = 154
 Score = 150 (57.9 bits), Expect = 3.7e-10, P = 3.7e-10
 Identities = 47/151 (31%), Positives = 68/151 (45%)

```

SEQ ID NO:2 120 LLSDSMLVEARAEASEEDLILVHTRRYLNELLKWSFAVATITEIIPPVIFLPNFLVQRKVLRP 179
          LL DS + R+A+EE+L H+ Y++ L+ E + N LV P
Begin SEQ ID NO:6 *-> LLDSEIYRPRKATEEEELTREHSEEEYIDFLRSVTPDNMQEEYSKQMERFNGLGVGEDDDCP

180 L-----RTQTGGTIMAGKLAVERGWAINVGGF---HHCSSDRGGGFCAYADITLA 227
          R GG+I A + +E G A N + HH GFC + D+ +A
          VFDGLYEEFCRLLAAGGSIEAAEKVME-GEADNGFANWRPPGHAAKKSEASGFCYFNDVAIA

228 IKFLFERVEGISRATIIDLDAHQGNNGHERDF 258 SEQ ID NO:2
          +K L +R G+ R IID D H GNG + F
          VKHLLKRRHGKVKRVLIIDWDVHHGNGTQEIF <- * End SEQ ID NO:6
  
```

Figure 3B

>PD021448 p2001.1 HISTONE DEACETYLASE Length = 142
Score = 394 (143.8 bits), Expect = 9.6e-37, P = 9.6e-37
Identities = 79/1122 (64%), Positives = 89/1122 (72%)

SEQ ID NO:2 251 GNGHERDFMDDKRVYIMDVYNRHIYPGDRFAKQAIRRKVELEWGTEDDEYLDKVERNKK 310
GNG R F DD VY + YN H YP F KQA R V LE GTEDDEYL +ER+I++
Begin SEQ ID NO:7 *-> GNGTARLFTDDPAVYTIFTYNMHCYPNYPFRQASRMDVGLENGTEDDEYLDQVLERHIEQ

311 SLQEEHLPDVYVYNAGTDILEGDRLLGGLISISPAGIVKRDDELVERMVRGRRVPILMVTSGGY 370
SL EH PD+V+YNAGTD+LEGDRLL+LEGDRLG L+ISPAGIVKRD LVFRM R VPI+ V GGY
SLNEHRPDLVIYNAGTDYLEGDRLLGNLAISPAGIVKRDRLVFRMARAAGVPIVCVIGGGY

371 QK 372 SEQ ID NO:2
QK
QK <-* End SEQ ID NO:7

Figure 3C

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(71) Applicant (for all designated States except US): MILLENNIUM PHARMACEUTICALS, INC. [US/US]; 75 Sidney Street, Cambridge, MA 02139 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): MEYERS, Rachel, E. [US/US]; 115 Devonshire Road, Newton, MA 02468 (US).

(74) Agents: MYERS, Louis et al.; Fish & Richardson P.C., 225 Franklin Street, Boston, MA 02110-2804 (US).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.



WO 02/008273 A3

(54) Title: 47508, A NOVEL HUMAN HISTONE DEACETYLASE FAMILY MEMBER AND USES THEREOF

(57) Abstract: The invention provides isolated nucleic acids molecules, designated 47508 nucleic acid molecules, which encode novel human histone deacetylase members. The invention also provides antisense nucleic molecules, recombinant expression vectors containing 47508 nucleic acid molecules, host cells into which the expression vectors have been introduced, and nonhuman transgenic animals in which a 47508 gene has been introduced or disrupted. The invention still further provides isolated 47508 proteins, fusion proteins, antigenic peptides and anti-47508 antibodies. Diagnostic methods utilizing compositions of the invention are also provided.

INTERNATIONAL SEARCH REPORT

In
onal Application No
PCT/US 01/23153

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C12N15/55 C12N9/16 C07K16/40 C12Q1/68 G01N33/50
G01N33/577

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07K C12N G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, MEDLINE, WPI Data, PAJ, BIOSIS, EMBL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CRESS W DOUGLAS ET AL: "Histone deacetylases, transcriptional control, and cancer." JOURNAL OF CELLULAR PHYSIOLOGY, vol. 184, no. 1, July 2000 (2000-07), pages 1-16, XP008010186 ISSN: 0021-9541 published online 19-5-2000 the whole document ----	1-20
A	DATABASE EMBL 'Online' HSM802049 standard; RNA; HUM; 1379 bp, 18 February 2000 (2000-02-18) ANSORGE W. ET AL.: "Homo sapiens mRNA; cDNA DKFZp434C0926; partial" Database accession no. AL137362 XP002220076 the whole document ----	1 -/-



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
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- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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& document member of the same patent family

Date of the actual completion of the international search

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel: (+31-70) 340-2040, Tx: 31 651 epo nl.
Fax: (+31-70) 340-3016

Authorized officer

Kools, P

INTERNATIONAL SEARCH REPORT

Int'l Application No
PCT/US 01/23153

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GROZINGER CHRISTINA M ET AL: "Three proteins define a class of human histone deacetylases related to yeast Hdalp" PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF USA, NATIONAL ACADEMY OF SCIENCE, WASHINGTON, US, vol. 96, no. 9, 27 April 1999 (1999-04-27), pages 4868-4873, XP002159644 ISSN: 0027-8424 the whole document ---	1-20
A	VERDEL ANDRE ET AL: "Identification of a new family of high eukaryotic histone deacetylases: Coordinate expression of differentiation-dependent chromatin modifiers" JOURNAL OF BIOLOGICAL CHEMISTRY, AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS, BALTIMORE, MD, US, vol. 274, no. 4, 22 January 1999 (1999-01-22), pages 2440-2445, XP002159646 ISSN: 0021-9258 the whole document ---	1-20
A	WO 00 10583 A (SMITHKLINE BEECHAM CORP) 2 March 2000 (2000-03-02) the whole document ---	1-20
A	DANGOND F ET AL: "Differential display cloning of a novel human histone deacetylase (HDAC3) cDNA from PHA-activated immune cells" BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS, ACADEMIC PRESS INC. ORLANDO, FL, US, vol. 242, 1998, pages 648-652, XP002124614 ISSN: 0006-291X the whole document -----	1-10, 12-14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 01/23153

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
Although claims 17-20 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound.
2. Claims Nos.: 9, 11-14, and 16-20, partially because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of Invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

The additional search fees were accompanied by the applicant's protest.
 No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 9, 11-14, and 16-20, partially

Claim 9 is directed to a method of detecting the polypeptide of claim 5 with a compound which is defined by reference to a desirable characteristic or property, namely selectively binding to said polypeptide.

Claim 11 relates to a kit comprising such compound.

Present claims 12 and 13 are directed to a method for detecting the presence of the nucleic acid of claim 1 by contacting the sample with a compound which is defined by reference to a desirable characteristic or property, namely selectively hybridizing to the nucleic acid molecule of claim 1.

Claim 14 relates to a kit comprising such compound.

Furthermore, claims 16, 18, and 19 relate to a method for modulating the activity of a polypeptide of claim 5 in a sample by contacting the polypeptide with a compound which is defined by reference to a desirable characteristic or property, namely binding to the polypeptide of claim 5.

Claim 17 is directed to a method of inhibiting aberrant activity of a 47508 expressing cell by contacting with a compound with a desirable characteristic being, modulating the activity of a polypeptide of claim 5.

Furthermore, claim 20 relates to a method of treating or preventing a disorder by administering a compound characterized by a desirable characteristic or property, namely modulating the activity of the polypeptide of claim 5 such that the aberrant activity is reduced or inhibited.

The claims cover all compounds and modulators and binding partners having this characteristic or property, whereas the application provides no support within the meaning of Article 6 PCT and/or disclosure within the meaning of Article 5 PCT for all such compounds and modulators and binding partners.

In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. Independent of the above reasoning, the claims also lack clarity (Article 6 PCT). An attempt is made to define the compounds and modulators and binding partners by reference to a result to be achieved. Again, this lack of clarity in the present case is such as to render a meaningful search over the whole of the claimed scope impossible.

Consequently, the search has been carried out for those parts of claims 9, 11-14, 16-20 which appear to be clear, supported and disclosed, namely

FURTHER INFORMATION CONTINUED FROM PCT/SA/ 210

those parts relating to antibodies specific for the polypeptide of claim 5, the polypeptide of claim 5, and polynucleotides of claim 1.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 01/23153

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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